CGAHR
Center for Grain & Animal Health Research

Research Kernels

Our Latest Research Results - November 2013 part 1

Analysis of a digestive prolyl carboxypeptidase in *Tenebrio molitor* larvae

Authors: I.A. Goptar, D.A. Shagin, I.A. Shagina, E.S. Mudrik, Y.A. Smirnova, D.P. Zhuzhikov, M.A. Belozersky, Y.E. Dunaevsky, B.S. Oppert, I.Y. Filippova,E.N. Elpidina
Submitted to: Insect Biochemistry and Molecular Biology
We are studying enzymes in insects to determine their function and whether we can interfere with the way that they operate to develop new insect control methods. We examined the function of one enzyme, prolyl carboxypeptidase (PRCP), in the gut of the yellow mealworm, a pest of stored products. We discovered that PRCP aids in the digestion of proteins in cereals. Our data indicate that the enzyme may be a target for the development of new control methods to prevent damage to stored grains and products.
Contact Brenda Oppert, telephone 785-776-2708, email Brenda.Oppert@ars.usda.gov

Rationale for a generic phytosanitary irradiation dose of 70 Gy for the genus *Anastrepha* (Diptera: Tephritidae)

Authors: G.J. Hallman
Submitted to: The Florida Entomologist
The irradiation literature of the tephritid fruit fly genus *Anastrepha* was studied to determine if a generic dose less than150 Gy (the current generic dose for all of Tephritidae) could be supported in areas of the tropical and subtropical Americas where only species of *Anastrepha* are quarantine pests. Although *Anastrepha* contains more than230 species only seven are consistently quarantine pests, and relevant research has been done on all but one of those seven. The measure of efficacy for phytosanitary irradiation of Tephritidae is prevention of adult emergence when eggs or larvae are irradiated in fruit. The last larval stage is the most tolerant to radiation. An argument for a generic dose of 70 Gy is based on homogeneity in response to radiation within *Anastrepha* and the fact that the International Plant Protection Convention has approved does of 70 Gy for some species.
Contact Guy Hallman, telephone 785-776-2706, email Guy.Hallman@ars.usda.gov

Impact of marker ascertainment bias on genomic selection accuracy and estimates of genetic diversity

Authors: N. Heslot, J. Rutkoski, J.A. Poland, J.L. Jannink, M.E. Sorrells
Submitted to: PLoS Genetics
To use molecular DNA markers in a breeding program for prediction of traits and selection of superior lines or to understand the diversity in germplasm collections, it is important that the molecular markers are an accurate representation of the overall population under study. Marker bias can arise when molecular markers are discovered in one set of material and then applied to a different set of lines. Newly developed methods for genotyping that rely on DNA sequencing have the advantage of discovering polymorphisms at the same time they are assayed in the population. Using this 'genotyping-by-sequencing' (GBS) approach, a set of 365 winter wheat breeding lines was evaluated. These lines were also genotyping using DArT (Diversity Array Technology) markers, which is a fixed array platform that has formed the basis of most of our knowledge about cereals genetic diversity and is used for genomic selection. It was found that the GBS markers gave higher prediction accuracy for genomic selection and that relative to DArT markers, the GBS markers captured more of the genetic diversity in the population. There are many more GBS markers than DArT markers so an equal number of markers from each set were compared. When using equal number of markers there was not a difference in prediction accuracy between GBS and DArT suggesting that the increased accuracy is largely due to having more markers in the GBS dataset. We conclude that GBS markers are a usable platform for genomic selection and a preferable platform for assessing genetic diversity due to the simultaneous discovery and typing of DNA polymorphisms.
Contact Jesse Poland, telephone 785-532-2709, email Jesse.Poland@ars.usda.gov

Dedicated Bioenergy Crop Impacts on Soil Wind Erodibility and Organic Carbon in Kansas

Authors: B.J. Evers, H. Blanco-Canqui, S. Staggenborg, J. Tatarko
Submitted to: Agronomy Journal
Crops grown for bioenergy such as perennial warm-season grasses (WSGs) may reduce soil erosion and improve soil properties while providing biomass

feedstock for biofuel. We quantified impacts of perennial WSGs and row crops on soil wind erodibility parameters (erodible fraction, geometric mean diameter of dry aggregates, and aggregate stability) and soil organic carbon (SOC) concentration under a dedicated bioenergy crop experiment in eastern Kansas after 4 and 5 years of management. Soil properties were measured under switchgrass, big bluestem, miscanthus, and annual row crops including continuous corn, photoperiod sorghum, sweet sorghum, and grain sorghum. Perennial WSGs reduced wind erodible fraction by 1.08 to 1.16 times compared with row crops. The geometric mean diameter of dry aggregates under switchgrass and miscanthus was 2.8 to 4.5 times greater than under row crops. Dry soil aggregate stability under miscanthus and big bluestem was greater than under row crops. After 5 yr, differences in SOC concentration between WSGs and row crops were not statistically significant for the 0- to 15-cm depth. Photoperiod sensitive and sweet sorghum had greater biomass yield than WSGs. In 2011, miscanthus yielded more biomass than corn by 5.3 Mg ha-1. Overall, growing dedicated bioenergy crops can reduce the soil's susceptibility to wind erosion but may not significantly increase SOC concentration in this region in the short term.
Contact John Tatarko, telephone 785-537-5542, email John.Tatarko@ars.usda.gov

Methods for assessing infestations of sunflower stem weevil, *Cylindrocopturus adspersus* (Coleoptera: Curculionidae) in sunflower stem

Authors: J.R. Prasifka, J.F. Campbell, R.M. Aiken, J.D. Bradshaw
Submitted to: The Canadian Entomologist
Sunflower stem weevils reduce sunflower yields by promoting diseases, damaging vascular tissues, and causing lodging of sunflower plants. To measure weevil populations for host plant resistance or insecticide field trials, usually larvae are dissected out of stems, a process that is slow and expensive. Alternative methods to estimate weevil populations include digital radiographs (X-rays) of stem sections or rearing out overwintering stem weevils. When tested, digital X-rays of small stem pieces (15 cm above soil level) explained most of the variation in numbers of weevil larvae from dissected stem samples (50 cm), but required less than one-fifth the time of manual dissection. Using emergence boxes to estimate weevil populations was similarly time-efficient, but may not be easily related to weevils per plant because of parasitism and death of weevil larvae inside the stems. Results suggest for large field trials with sunflower stem weevils, digital X-rays provide much more cost-efficient larval population estimates, increasing researchers' ability to detect differences among treatments.
Contact Jim Campbell, telephone 785-776-2717, email James.Campbell@ars.usda.gov

Using near-infra red spectroscopy to predict the age of a mix of insecticide-resistant *Anopheles* species with a wild genetic background

Authors: M.T. Sikulu, S. Majambere, B.O. Khatib, A.S. Ali, F.E. Dowell, L.E. Hugo, G.F. Killeen
Submitted to: American Journal of Tropical Medicine and Hygiene.
Estimating mosquito age is important for determining their ability to transmit malaria since only older mosquitoes can transmit this parasite. A rapid and cost-effective method to determine the age of large numbers of mosquito populations is needed. We report on the accuracy of using near-infrared spectroscopy (NIRS) to predict the age of *Anopheles* mosquitoes and used to asses resistance to pesticides. Larvae were collected in the wild and reared at fluctuating temperature and humidity. Adult mosquitoes were collected at 1, 3, 5, 7, 9 and 14 d post-emergence. Mosquitoes were exposed to 0.05% Lambdacyhalothrin. NIRS was used to predict the age of all unexposed and exposed laboratory-reared and wild-collected mosquitoes. For the laboratory-reared mosquitoes, the range of prediction varied from ±3 to ±7 d of their actual age. An accuracy of 79% was obtained when mosquitoes were predicted into <7 or ≥7 d age groups. The age structure of wild collected mosquitoes was not significantly different for pyrethroid susceptible and resistant mosquitoes. The accuracy of NIRS for predicting a mixture of *Anopheles* mosquitoes, with a wild genetic background, matches the accuracy obtained from previous studies. This is a good indicator as it means this tool can be applied to predict a range of other mosquito species.
Contact Floyd Dowell, telephone 785-776-2753, email Floyd.Dowell@ars.usda.gov

USDA-ARS Center for Grain and Animal Health Research

1515 College Avenue
Manhattan, KS 66502

800-627-0388
ars.usda.gov/npa/cgahr

CGAHR
Center for Grain & Animal Health Research

Research Kernels

Our Latest Research Results - November 2013 part 2

The influence of physiological status on age prediction of *Anopheles arabiensis* using near infra-red spectroscopy

Authors: A. Ntamatungiro, V. Mayagaya, S. Rieben, S. Moore, F. Dowell, M. Maia
Submitted to: Parasites and Vectors

Determining the age of mosquitoes that transmit malaria is essential for evaluating the impact of methods that reduce the survival of wild mosquito populations. Near infra-red spectroscopy (NIRS) is a simple and non-destructive method that has been used to determine the age and species of *Anopheles gambiae* s.l. by analyzing differences in absorption spectra. The spectra are affected by biochemical changes that occur during the life of a mosquito. To better understand these changes, we evaluated the influence of mosquito physiological status on NIR spectra. Mosquitoes of the same chronological age, but at different physiological stages, were scanned and compared. We observed that older insects tend to be predicted as being physiologically more mature. NIRS could be used to predict physiological status but with considerable overlap within physiological stages. Our results shows that users who wish to use NIR technology to predict the age of field-caught *Anopheles gambiae* s.l should use a calibration that includes diverse ages and physiological stages to increase the robustness and accuracy of the model.
Contact Floyd Dowell, telephone 785-776-2753, email Floyd.Dowell@ars.usda.gov

Military vehicle trafficking impacts vegetation and soil bulk density at Fort Benning, Georgia

Authors: A. Retta, L.E. Wagner, J. Tatarko
Submitted to: Transactions of the ASABE

Potential increases in wind erosion caused by military vehicles travelling off-road during training exercises are of concern to the United States military. The U.S. Department of Agriculture-Agricultural Research Service (ARS) recently developed the Wind Erosion Prediction System (WEPS) model to estimate risk of wind erosion events on agricultural croplands. With appropriate modifications, WEPS could be used as a decision aid in developing site-specific training schedules which minimize adverse impacts to the soil surface and vegetation cover due to off-road trafficking as well as provide reasonable estimates of possible increases in PM_{10} (particulate matter less than 10 microns) in the dust plume arising from such activities. However, availability of suitable data for use with WEPS at military installations is limited. To fill this knowledge gap a project was initiated to conduct field experiments at military bases in different geographical and climatic regions of the country. Soil, vegetation, and surface condition data before and after vehicular trafficking were obtained in field experiments conducted in July 2012 at Fort Benning, Georgia. Among the data collected were bulk density, biomass, and vegetative cover before and after different trafficking intensities created by two vehicle types (wheeled vs. tracked). Vegetative cover showed a strong response to vehicle type, trafficking intensity, location (within the vehicle tracks), and their interactions. Regression equations relating trafficking intensity to reduction in cover were developed to give reasonable estimates of the loss of vegetative cover resulting from trafficking by tracked or wheeled vehicles. The surface layer bulk density (0-5 cm depth) was significantly greater after trafficking with both the M1A1 Abrams tank and HMMWV (Humvee). The results from this experiment can be used to assess dust emissions and wind erosion potential resulting from military training activities at Fort Benning.
Contact John Tatarko, telephone 785-537-5542, email John.Tatarko@ars.usda.gov

Sorting of fungal-damaged white sorghum

Authors: T. Pearson, D. Wicklow, S. Bean, D. Brabec
Submitted to: American Journal of Agricultural Science and Technology

Fungal infected sorghum grains are not suitable to use in food products and have reduced germination rates. While there are commercial sorting systems that can remove sorghum grains having severe discolorations due to fungal damage, many fungal damaged grains cannot be removed by these systems as the fungi may only cause minor discolorations in the form of several tiny spots on the surface of the grain. To address this issue an improved electronic-optical sorting system was developed to identify and remove sorghum kernels that have both large discolorations and several tiny spots. The system uses a color image sensor and digital processor programmed to detect most types of fungal damaged sorghum. Results indicate that nearly 100% of the grains with large discolorations and 90% of the grains with tiny spots can be separated from clean sorghum with only a 10% error rate on the clean sorghum. The throughput of the system is approximately 30 kg/hr. The sorting system can be used to improve the sorghum quality of food products and seed germination rates and might also be used for other

grains or pulse crops for which seeds with localized spots need to be removed.
Contact Tom Pearson, telephone 785-776-2729, email Thomas.Pearson@ars.usda.gov

Development and evaluation of a near-infrared instrument for single-seed compositional measurement of small seeds

Author: P.R. Armstrong
Submitted to: Cereal Chemistry
An instrument designed to measure single-seed composition was built and tested and its performance was evaluated using wheat kernels. The instrument uses near-infrared spectroscopy to measure seed composition on a continuous flow of singulated seeds. Single-seed protein, moisture content and mass of wheat kernels were used to evaluate the instrument. The instrument was shown to measure protein and moisture very well while seed mass was less accurate but still provided a useful measurement. Protein measurements were measured to within 0.7% of their true value, moisture content within 0.5% and kernel mass within 4 mg of true mass. The instrument measures seeds at a rate of at least 4 per second making it useful for small sample evaluation and can provide a useful tool for plant breeders wanting to evaluate compositional characteristics of breeding lines or selection of specific seeds and has potential for detecting disease symptoms or disease resistance.
Contact Paul Armstrong, telephone 785-776-2728, email Paul.Armstrong@ars.usda.gov

Ruggedness of 2D Code Printed on Grain Tracers for Grain Traceability System

Authors: K. Liang, J.A. Thomasson, M.X. Shen, P.R. Armstrong, Y. Ge, K.M. Lee, T.J. Herrman
Submitted to: Food Control
Tracing grain from the farm to its final processing destination as it moves through multiple grain handling systems, storage bins and bulk carriers presents numerous challenges to existing recordkeeping systems. This study examined the suitability of bar-coded grain tracers, embedded within the grain, to withstand the rigors of a commercial grain handling operations as defined by the readability of the tracers before and after handling. Sugar and cellulose tracers, based on food grade material, were manufactured and coded using two different exterior coatings for protection. Readability of tracers was done with a common handheld bar-code scanner. The readability of the cellulose based tracers printed with a dot-matrix barcode using food grade ink and coated with hydroxypropyl methylcellulose, was found to perform satisfactorily whereas others did not perform well. This particular type of tracer is considered to be suitable for implementation as a component of a commercial tracing system.
Contact Paul Armstrong, telephone 785-776-2728, email Paul.Armstrong@ars.usda.gov

Registration of Near-Isogenic Winter Wheat Germplasm Contrasting in *Fhb1* for Fusarium Head Blight Resistance

Authors: A. Bernardo, G. Bai, J. Yu, F. Kolb, W. Bockus, Y. Dong
Submitted to: Journal of Plant Registrations
The Chinese wheat Ning7840 (*Triticum aestivum* L.) contains *Fhb1,* a major gene for Fusarium head blight (FHB) resistance. However Ning7840 poorly adapts to US wheat growing environments, its progenies usually exhibit reduced grain yield if it is directly used as a parent. We developed five near-isogenic lines (NILs) (NIL75, Reg. No. GS-174, PI 668559; NIL78, Reg. No. GS-175, PI 668560; NIL80, Reg. No. GS-176, PI 668561; NIL90, Reg. No. GS-177, PI 668562; NIL98, Reg. No. GS-178, PI 668563) that contain *Fhb*1 gene from Ning7840 but other genome content from a US winter wheat, Clark. DNA marker and FHB data confirm the presence of *Fhb1* gene in the four resistant NILs and absence the gene in the susceptible NIL. All resistant NILs had significantly higher FHB resistance and lower deoxynivalenol (DON), a mycotoxin produced by the pathogen, than Clark and the susceptible NIL but yield similar to Clark. These *Fhb1* NILs should be useful parents for effective use of *Fhb1* in US winter wheat.
Contact Guihua Bai, telephone 785-532-1124, email Guihua.Bai@ars.usda.gov

USDA-ARS Center for Grain and Animal Health Research

1515 College Avenue
Manhattan, KS 66502

800-627-0388
ars.usda.gov/npa/cgahr