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Tangerine Blush: Engineering Soybean to Produce β -carotene in Seed Cotyledons

Blake L. Joyce and Wayne Parrott

Field Scale Dispersion Measured with Tile Drains

Frantisek Majcs, David E. Radcliffe, and John C. Seaman

A Comparison in Cotton of Mepiquat Chloride Activity with and without Cyclanilide Addition

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Discovery and Mapping of SNP Markers Associated with Fatty Acid Content in Soybean

Maria J. Monteros, Perry B. Cregan, and H. Roger Boerma

Sediment Source Identification in a River segment Using High Resolution Aerial Photography

Rajith Mukundan

PCR Markers Based on Gene Introns

Pawan Kumar and Peng W. Chee

Interaction of 2,4,6-Trinitrotoluene with Clay Minerals and Humic-Clay Complexes

Greg D. Pillar and Kang Xia

Cries for help: Remotely sensing water-stressed cotton

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Abstracts

Model Calibration for Sediment Concentration in a Small Agricultural Watershed

*J. Kenneth Bradshaw, D.E. Radcliffe, L.M. Risse, M. Bakker, C.R. Jackson,
D. Markewitz, and K.P. Lichtenstein*

The USEPA requires that sources of contaminants be identified for development of Total Maximum Daily Loads (TMDL). We used the Soil Water Assessment Tool (SWAT) to determine the source of stream sediments and potential best management practices for decreasing stream sediment inputs. Water balance parameters were adjusted to calibrate SWAT for flow and MUSLE parameters were adjusted to calibrate for total suspended solids (TSS). Simulated flow was significantly lower than observed flow during the first simulations. Point source inputs were added into the watershed model to compensate for pumped water (used by the dairy operations). Average mean absolute error for flow was ± 0.037 cms. Average mean absolute error for TSS was ± 222.31 mg/L. Poor model fit of TSS between storms may be the effect cattle in the stream. Overall there was a good agreement between observed and simulated flow but not between observed and simulated TSS.

Phosphorus Export from Aerated Grasslands

Dave Butler, Dorcas Franklin, Miguel Cabrera, Kang Xia, and Armando Tasistro.

Surface-applied manures are of particular concern in the Southern Piedmont (USA) because of a high concentration of broiler production. As these manures can contribute to P in runoff, a study was conducted to examine the water conservation potential of mechanical aeration of grasslands which has potential to reduce P transport by increasing infiltration of rainfall and binding of P with clay minerals. The effects of four aeration treatments (disk aeration perpendicular to the slope, aeration with cores, aeration with spikes, and no aeration treatment) on the export of total Kjeldahl P (TKP) and dissolved reactive P (DRP) in surface runoff from grasslands with two nutrient treatments (broiler litter and no manure) were examined. Plots (0.75 x 2 m) were established on a Cecil soil series with mixed tall fescue/bermudagrass vegetation on 8 to 12% slopes. Simulated rainfall was applied at a rate of 75 mm h⁻¹ to evaluate baseline conditions. Plots were then aerated and manures applied at a rate of 30 kg P ha⁻¹, prior to additional rainfall simulations. Results indicate core aeration decreased TKP and DRP loads ($P < 0.05$) from applied broiler litter by 46 and 62%, respectively. Because Cecil soil is common in pastures receiving broiler litter in the Southern Piedmont, these results suggest that core aeration could have a widespread impact on water quality in the Southern Piedmont region.

Discovery of Stress-Responsive *Cynodon* Genes by cDNA Sequences and Expression Profiles

Changsoo Kim, Terry L. Kamps, Andrew H. Paterson

Building on our development of the first 'genetic map' of the *Cynodon* genome, we are conducting the first large-scale exploration of EST sequences in *Cynodon dactylon* L., representing the underexplored Chloridoid clade of the Poaceae (cereals). Further, we are using these resources to identify genes that are turned on or off in response to environmental stresses, emphasizing drought. We constructed a cDNA library from *C. dactylon* T89, one parent of the genetic mapping population. The cDNA library was normalized to minimize the levels of abundant transcripts such as Rubisco, so we did not waste resources on repetitively sequencing such genes. After constructing the library, we sequenced 4,608 clones from the library and those were spotted onto a nylon membrane for gene expression profiling during drought stress treatment. Then, radioactively labeled cDNA from bermudagrass subjected to different levels of managed drought-stress was hybridized to the membranes. Macroarray filters are being analyzed to identify drought-responsive genes. Through both EST sequences and gene expression profiling, this research will benefit the entire *Cynodon* community by improving knowledge of stress response.

Tangerine Blush: Engineering Soybean to Produce β -carotene in Seed Cotyledons

Blake L. Joyce, Wayne Parrott

Consumers associate quality of food with color and flavor. Without certain carotenoids egg yolks, butter, and even shrimp would be white instead of their natural color. Soybean meal is a chief source of animal feed in the US but is devoid of carotenoids. If soybean feed already contained carotenoids, farming industries would have a more economical choice for animal feed. The goal of the project was to genetically engineer soybean to produce carotene, the precursor for other agriculturally important carotenoids. Soybean embryos were transformed using microprojectile bombardment with a plasmid containing the phytoene synthase (*crtB*) from *Erwinia uredovora* gene for phytoene, placed behind a cotyledon specific promoter and with hygromycin resistance as the selectable marker. Endogenous soybean enzymes then change the phytoene into β -Carotene. Three engineered lines were obtained. One line of the three turned orange, denoting the successful expression of carotene in the seed tissues. Engineering with additional genes for carotenoid synthesis should allow for production of other carotenoids, such as canthaxanthin.

Field Scale Dispersion Measured with Tile Drains

Frantisek Majš, David E. Radcliffe, and John C. Seaman

The use of tile drains has been suggested as a method of measuring field-scale transport parameters, but lateral flow to the drains in the saturated zone prevents a simple 1D analysis. Our objective was to fit field data using Hydrus-2D, a computer program that numerically solves Richards equation for describing saturated-unsaturated flow and the convection-dispersion equation for solute transport. Two breakthrough curves, using Cl^- as a tracer, were obtained from a 12.5 by 30.5-m plot drained by five tile drains under two irrigation rates of 0.25 and 0.45 cm h^{-1} respectively. The inverse optimization feature of Hydrus-2D was used to optimize saturated hydraulic conductivity and n and alpha parameters of van Genuchten's (1980) soil water characteristic curve equation and longitudinal dispersivity. Saturated hydraulic conductivity, n , and alpha parameters were first optimized using tile drain flow data at the two irrigation rates. Longitudinal dispersivity was subsequently optimized using measured tile-drain Cl^- concentrations. The optimized longitudinal dispersivities for the unsaturated zone at the higher irrigation rate were about twice that for the lower irrigation rate. This illustrates the effect of preferential flow on field-scale solute transport.

A Comparison in Cotton of Mepiquat Chloride Activity with and without Cyclanilide Addition

Rob Millings

The growth habits of cotton (*Gossypium hirsutum*) are rather different from other crops utilized in production agriculture. By its general nature cotton is a perennial plant with indeterminate growth habits and yet is grown as an annual. This type of growth can produce wasted vegetative growth, wasting resources that would be better allocated to fruit production. Vegetative growth in cotton has been controlled in recent years with a variety of plant growth regulators (PGRs), particularly mepiquat chloride. However, a new product “Stance”, developed by Bayer CropScience, shows potential as a new PGR. This product is composed of mepiquat chloride, which is used in most cotton PGRs, and a new chemical, cyclanilide, a presumed auxin transport inhibitor. Mepiquat chloride reduces internode growth by inhibiting the production of gibberellic acid, the hormone responsible in part for internode elongation. Cyclanilide is a chemical that shares the characteristics of TIBA (2,3,5-triiodobenzoic acid), a known auxin transport inhibitor (Pedersen et. al., 2001). Auxin is a hormone that is necessary to allow gibberellic acid to be metabolized from an inactive form (GA₂₀) to an active form (GA₁) (Ross et. al., 2003). The inhibition of auxin transport may not inhibit all GA biosynthesis within the plant, but it does reduce internode growth within the plant. The combination of these two chemicals offers a new method of controlling vegetative growth in cotton, and may offer a quicker response than just mepiquat chloride alone. It is believed that this product may have other physiological affects on cotton that might influence production and harvest methods, quality, and yield. The research protocol for this experiment involves three separate rates of application of “Stance” compared with mepiquat chloride and the control. These rates are 146, 183, 219mL/hectare of “Stance” and then the recommended rate of mepiquat chloride, which starts out at 584mL/hectare and typically increases. These applications are typically applied during particular stages of development among the cotton plants to maintain a height between 122cm to 137cm. This height range provides a balance between plant structure and fruit development and production.

Discovery and Mapping of SNP Markers Associated with Fatty Acid Content in Soybean

Maria J. Monteros, Perry B. Cregan, and H. Roger Boerma

An increase in the amount of oleic acid in soybean oil would decrease its total saturated fatty acid content and reduce the need for hydrogenation, which creates unhealthy trans fatty acids. Oleic acid QTL from N00-3350 soybean (~55 % oleic acid) have been mapped to linkage groups (LG) A1, D2, G, and L. The objectives of this study were to identify the genes likely involved in previously mapped oleic acid QTL, map the location of genes from the fatty acid synthesis pathway, and develop single nucleotide polymorphism (SNPs) markers in these areas to use for marker-assisted selection (MAS). PCR primers were developed from BACs anchored to the physical map in areas previously associated with oleic acid QTL, from soybean EST sequences, and from genes in the fatty acid synthesis pathway from other species, including *Arabidopsis thaliana*, *Helianthus annuus*, *Brassica juncea*, and *Olea europaea*. An F_{2:3} population of 316 individuals derived from the cross of G99-G725 (~18% 18:1) x N00-3350 was used to map the location of the markers developed, and to estimate the percent variation explained by the markers. Polymorphisms were initially detected using single-strand conformational polymorphism (SSCP) gels. Individual PCR amplicons from the parents were excised from gels, re-amplified, and sequenced. A total of 130 markers developed from these sequences have been tested. Thus far, we have identified and mapped SNP markers on three linkage groups where oleic acid QTL had previously been identified (LG-A1, D2, and G). Using these approaches we have been able to obtain a higher resolution in mapping areas of the soybean genome associated with oleic acid, predict some of the genes responsible for the oleic acid phenotype, and identify SNPs that can be used by breeders for MAS to incorporate desirable alleles for fatty acid content into elite cultivars.

Sediment Source Identification in a River segment Using High Resolution Aerial Photography

Rajith Mukundan

Sediment is the single most important water quality problem and the largest contributor by volume of non-point source pollution in the United States. About 17% of the waterbodies in the United States are listed for sediment problem. Section 303(d) of the 1972 Clean Water Act (CWA) requires states to identify water bodies that do not meet the federal standards for their designated uses. However, even after thirty years of pollution control efforts, the best way to identify the source of sediment in streams and managing it is still a topic for discussion.

Remote sensing technology offers an effective tool in identifying the critical sediment source areas in an impaired stream or river segment and helps prioritize sediment control measures. Satellite remote sensing has limitations when the size of the stream is small. However, aerial photography can cater such needs by its possibility of adjusting the image resolution by controlling the flying height of the aircraft and obtain images of sub-meter resolution.

A 1 km stretch of the Oconee River, one of the water bodies in Georgia in the list of impaired waters due to high levels of sediment was considered for this study. Unsupervised classification of a high resolution aerial photograph was performed to identify the critical sediment source areas in the selected river segment and establish a relationship between spectral reflectance and turbidity.

PCR Markers Based on Gene Introns

Pawan Kumar and Peng W. Chee

Among the transcribed regions of a gene, introns are the most polymorphic and therefore are ideally suited for developing molecular markers. However, the identification of intron regions is not a straight-forward process, involving the alignment of EST or cDNA to their genomic counterpart. In cotton, this process is further exacerbated by the scarcity of cotton genomic DNA sequences in Genbank. In this study, we evaluated the possibility of utilizing genomic sequences from Arabidopsis, the genome of which has been completely sequenced, to locate intron regions in cotton. Cotton ESTs were BLAST-searched against the Arabidopsis database to identify orthologous genes. Cotton introns were identified with 92% success rate based on the alignment of cotton ESTs to Arabidopsis genomic DNA, demonstrating that this approach is both feasible and practical for predicting the locations of introns in cotton ESTs. A majority of cotton introns had the canonical GT-AG splice site junctions, facilitating their identification in the sequence alignment process. Sequence comparisons between *G. arboreum* and *G. raimondii* indicated that intron sequences harbor an almost four fold greater nucleotide variation than do the exons, with a majority of the differences due to a repeating thymine (T) or to the number of simple sequence repeat motifs.

Interaction of 2,4,6-Trinitrotoluene with Clay Minerals and Humic-Clay Complexes.

Greg D. Pillar and Kang Xia

Nitroaromatic compounds, such as 2,4,6-trinitrotoluene (TNT), are common munition-derived pollutants encountered at facilities used in the manufacturing, processing, and disposing of explosives. The environmental fate of TNT and other organic contaminants in soils is largely determined by its interaction with soil clay minerals and organic matter. Previous research has shown that humic acid can potentially impact the sorption of pesticides, such as dichlorbenil, to clay minerals. These studies show that humic acid had no impact on pesticide sorption by K^+ clays, but could either enhance or suppress sorption by Ca^{2+} -clays. However, it is not well known how the interaction between clay minerals and organic substances could facilitate the sorption of TNT. The objective of this study was to determine the effect humic substances have on the interaction between TNT and clay minerals. In this study, sorption and desorption of TNT by Ca^{2+} -, K^+ - smectite minerals along with the respective humic acid-clay complexes were examined using batch-equilibration and x-ray diffraction (XRD). The sorption of TNT on Ca^{2+} -, K^+ - smectite was significant and reached equilibrium within 2 h, however desorption hysteresis was observed for TNT with all sorbents. Humic acid had a wide ranging impact on TNT sorption depending on the type of smectite mineral and/or exchangeable cation. Overall, humic acid had the most significant impact on the sorption of TNT with the low charge smectite (SWy) resulting in a greater amount of TNT adsorbed in the interlayer region causing an increase in the basal spacing based on XRD analysis.

Cries for help: Remotely sensing water-stressed cotton

Glen Ritchie

Water is essential to quality crop production, but the increased water consumption in Georgia and the Southeast threatens to limit agricultural water availability in the future. Water pumping can also be expensive, especially during the summer when electricity is at a premium. The University of Georgia has pioneered much of the cotton irrigation technology in the Southeast aimed at improving irrigation efficiency, including variable rate technology, irrigation scheduling models, and studies of the effects of drought stress at various stages of plant growth. The use of aerial imagery as a method to detect when to water cotton is being used to enhance these technologies. Overhead pictures can identify plants approaching water stress by changes in crop growth and color. To measure these changes, two remote-controlled cameras were mounted to a mobile tethered blimp. One of the cameras has been modified to take near-infrared pictures, which helps with the stress detection. The pictures are analyzed and used to schedule irrigation. Results from 2003 to the present suggest that making irrigation decisions based on these aerial images can produce high yielding cotton while reducing the amount of water applied during the season. Although this research is still relatively new, it can potentially give producers another tool for irrigation scheduling.

Performance of Near-Isogenic Soybean Lines Developed by Marker-Assisted Selection for a Linkage Group I Protein QTL

Jennifer L. Yates and H. Roger Boerma

Although protein is a valuable component of soybean [*Glycine max* (L.) Merr.] seeds, the development of high-protein cultivars is hampered by the negative association of protein content with yield. A recently characterized allele at a protein QTL on linkage group (LG) I in the South Korean cultivar Danbaekkong was located in the 0.5-cM interval between Satt239 and Satt496. This allele increased protein content by 15 g kg⁻¹ when compared to the Benning allele. Backcross-derived near-isogenic lines of three elite cultivars, Haskell, Benning, and Prichard (390-400 g kg⁻¹ protein content), that were homozygous for the presence or absence of the high-protein Danbaekkong allele were tested in multi-location field trials in 2004 and 2005. Averaged across locations and recurrent parents' backgrounds, the protein content of the isolines homozygous for the Danbaekkong allele was 432 g kg⁻¹, while those homozygous for the recurrent parent alleles averaged 398 g kg⁻¹. Seed yield did not differ between the near-isolines homozygous for the Danbaekkong or the Prichard alleles, but was significantly lower in the near-isolines homozygous for the Danbaekkong high-protein allele in the Benning and Haskell backgrounds. Oil content, maturity, seed weight, and amino acid compositions also differed between the near-isolines, which are possible consequences of the high nitrogen demand in the lines with the Danbaekkong protein allele. Although this protein QTL has been identified in multiple mapping studies, this is the first study that evaluates the effects of the Danbaekkong allele on agronomic performance in soybean. These results demonstrate the efficacy of marker-assisted selection for this protein QTL and provide further incentive to clone the gene(s) responsible for the high-protein phenotype.

Factors Affecting Water Soluble Phosphorus (WSP) in Animal Wastes

Yebin B. Zhao, Kang Xia, Armando Tasistro, Miguel Cabrera, and Dorcas Franklin

Water soluble phosphorus (WSP) in animal wastes has received recent attention because phosphorus extraction by water may closely simulate extraction by rainfall and runoff water in the field. However, no comprehensive study has been conducted on WSP extraction from animal waste. In our preliminary work with broiler litter, increasing extracting ratio from 1:10 to 1:100 increased the amount of WSP extracted by 53%; extending shaking time from 2 to 24 h increased amount of extracted WSP by 18%. In broiler litters and layer manures study, we also found the amount of extracted WSP was 1 to 9 times higher under pH6 than original litter pH. This study continues to evaluate the effects of extraction time, manure: water extracting ratio, and suspension pH on WSP and bioavailable phosphorus (BP) in animal waste. Five samples of broiler litter, layer manure and dairy manure are selected to present the existing variability in manure composition. Samples are extracted at three extraction times (1, 4, and 24h), three extraction ratios (1:100, 1:100 and 1:200), two pH's (original animal waste pH, and pH 6). Total water dissolved phosphorus (TDP) is measured by inductively coupled plasma (ICP) spectrometry; dissolved reactive phosphorus (DRP) is tested by ascorbic acid colorimetric method; dissolved unreactive phosphorus (DUP) is the difference between TDP and DRP; BP is extracted by iron oxide-impregnated paper strips, and determined by ascorbic acid colorimetric method. By this study, we expected to provide more information on effects of extraction ratio, shaking time and pH to WSP extraction of animal waste.