



Solanaceae Coordinated Agricultural Project

Volume 4, Issue 2

June 2012

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Breeding In a Genomics Era: State of the Art and New Opportunities

A SolCAP Colloquium is scheduled for the upcoming American Society of [Horticultural Science Conference](#) July 31-August 3, 2012, at the InterContinental Hotel in Miami, Florida

The objectives of the colloquium will be to help bridge the gap between breeding, MAS and genotyping with agronomic crops and vegetable/horticultural crops, with a target audience of professionals and students involved in improvement and conservation of horticultural crops.

The sequencing of plant genomes and the development of genome wide SNP arrays for a number of agronomic and specialty-crops is leading to new opportunities to better understand the organization of variation in germplasm and to develop new breeding strategies. USDA funded large collaborative grant programs, such as The USDA-AFRI funded SolCAP and USDA-SCRI funded RosBREED projects as well as private/public partnerships exist and have aided in expediting the breeding process by funding research. The objectives of the colloquium will be to help bridge the gap between breeding, MAS and genotyping with agronomic crops and vegetable/horticultural crops, with a target audience of professionals and students involved in improvement and conservation of horticultural crops.

Wednesday, August 1, 2012: 2:00 PM
Location: Theater, InterContinental Hotel

Coordinators and Moderators:
David Douches, Ph.D. and Brian Irish, Ph.D.

2:00 PM
Mapping Economically Important Traits In Tetraploid Potato Using Genome-Wide SNPs
David Douches, Ph.D., Michigan State University

2:45 PM
The Population Genetics of Human Selection During 100 Years of Tomato Breeding: Implications to Gain Under Selection
David Francis, Ph.D., Ohio State University

3:30 PM
Successful DNA-Informed Breeding for Tree Fruit: The Rosbreed Experience
Cameron P. Peace, Ph.D., Washington State University

4:15 PM
Leveraging the Cacao Genome for the Identification of Genes Regulating Important Agronomic Traits
J.C. Motamayor, Ph.D., MARS Inc.

5:00 PM
Experience with Genome Wide Selection In Maize
Rex Bernardo, Ph.D., University of Minnesota

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Dave D.'s Perspective:

The development of a genome wide set of SNPs for potato and tomato was one of SolCAP's major goals. The Infinium potato and tomato SNP arrays provides a platform to more intensely study the potato and tomato genomes. We are now clearly in the genomics era. The potato diversity panel, composed of 325 genotypes, is a cornerstone of our translational work in potato. From this data set we can examine population structure as well as breeding progress over the past century. Numerous mapping populations from SolCAP and the broader community, both 2x and 4x, have been SNP genotyped so that QTL analysis can be conducted on economically important traits such as tuber sucrose, glucose, fructose and dry matter content as well as tuber shape, maturity, chip color, scab resistance, late blight resistance, etc. This work will be summarized this summer.



At the Potato Association of America, SolCAP will sponsor a fourth potato workshop in Denver, CO. On August 12, five presentations will be made by research teams that have a SNP-genotyped population and have experience in creating a genetic map and then conduct QTL analysis. The speakers include:

Candace Hirsch - "A Century of Potato Breeding: Improvement, Diversification, and Diversity"

Richard Veilleux - "Seeking and Verifying Candidate Genes on the Infinium 8303 Potato SNP Array"

Dave Douches - "SNP mapping and QTL analysis in a Tetraploid Mapping Population"

Sarah Braun (Shelley Jansky's student) - "A case study: What to do when your SNP data set arrives "

Jaebun Park (Walter De Jong's student) - " A new user's experience with TetraploidMap and solCAP SNPs for QTL analysis in potato "

The SolCAP SNPs continue to enjoy wide use in the tomato community. The Infinium array is providing a robust tool for hybrid and parent identity testing; high density genetic maps have been developed for numerous populations; and population level analysis is providing insight into the structure of domesticated populations, including elite breeding material. In a survey of over 356 cultivated varieties, the 7,720 SNPs from the array have yielded 7,500 polymorphic markers. Of these, 7,375 were extremely robust with less than 10% missing data. Based on SolCAP's analysis, recombination is limiting in cultivated germplasm with LD extending over cM. The detail provided by over seven thousand markers exceeds the recombination based resolution in most breeding populations. For this reason, SolCAP developed two sets of SNPs, optimized for fresh and processing market classes of tomato. The process of optimization involved filtering SNPs for polymorphic information content, genetic position, and physical position on the tomato genome. The Fresh-market SNPs have been commercialized through KBio-Sciences is based on allele-specific PCR and other companies and platforms. The SNPs optimized for processing germplasm are currently being used for community projects using the Illumina BeadXpress platform. In analysis of IBC and RIL populations, the SNPs are yielding high polymorphism rates of 222-263 of the 384 markers polymorphic in a given bi-parental population. Genetic maps based of these populations are yielding insight into the biology and selection history of processing tomatoes. More complex populations have yielded up to 357 segregating polymorphisms.

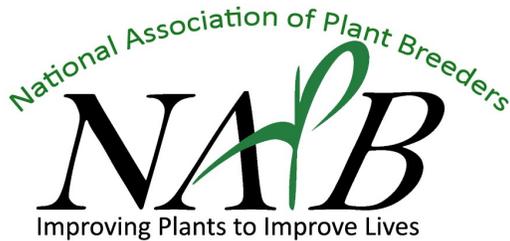
Both sets of optimized SNPs are available in spread sheet format (as comma delimited files) on the Plant Breeding and Genomics pages at eXtension (See URL: <http://www.extension.org/pages/61007/>). The SNPs are working well across several genotyping platforms and labs.

On August 1st, SolCAP, in collaboration with RosBreed (USDA/SCRI), will be sponsoring a colloquium on Breeding in the Genomics era. This will be held at the American Society of Horticultural Science meeting in Miami on August 1. Dave Francis and Dave Douches are leading the organization (continued on page 3)

Dave D.'s Perspective:

of the colloquium. The details of this meeting are presented on page 1 of this newsletter.

On August 9, SolCAP will be leading a Plant Breeding and Genomics (PBG) eXtension workshop at the National Association of Plant Breeders meeting in Indianapolis. The [Alliance for a Green Revolution in Africa](#) (AGRA) is sponsoring 8 plant breeding scientists and students and SolCAP, through a supplemental grant from the USDA will be funding 6 African scientists. We will be introducing the African plant breeders to the Community of Practice (CoP) and determining how the African breeders can more effectively interact with the PBG CoP.



Plant Breeding and Genomics Webinars

The Plant Breeding and Genomics (PBG) webinar series resumed in April with presentations from SolCAP. On April 5th, Dave Douches and Joe Coombs of Michigan State University entertained participants from 11 countries with a discussion of the development of tetraploid maps for potato. Dave and Joe described how they generated a map for a Premier Russet x Rio Grande Russet population and previewed results of recent QTL analysis. To help members of the community develop their own tetraploid maps, Dave and Joe walked through their mapping process: calling SNPs with five-clusters, filtering SNPs for tetraploid populations, formatting genotypic data for TetraploidMap, and generating a map with TetraploidMap. Early feedback from the survey evaluations suggests that Dave and Joe hit the mark; multiple participants reported that they plan to develop maps and conduct QTL analysis in tetraploids. The webinar recording is available at <http://www.extension.org/pages/63187>.

On April 12th, Allen Van Deynze of the University of California, Davis, shared a pipeline to facilitate genetic mapping with large datasets. Allen described preparation of data, as well as scripts and software to group, order, and visualize thousands of SNPs. Allen's webinar attracted over 100 breeders, students, and researchers who work with apple, bean, blueberry, carrot, maize, oat, peanut, soybean, sweet potato, tomato, wheat, and more. The recording is available at <http://www.extension.org/pages/63330>.

These webinars compliment five presentations from the Autumn PBG Webinar series. All recordings and supplemental material are available at www.extension.org/pages/60426.

Stay up to date by subscribing to pbgnews at <http://pbgworks.org>.

OSU unveils new purple tomato, 'Indigo Rose'

Author : Judy Scott, Oregon State University Extension Service

CORVALLIS, Ore. – The "Indigo Rose" tomato steps out this year as the first "really" purple variety to come from a program at Oregon State University that is seeking to breed tomatoes with high levels of antioxidants.

The new variety is a novelty type intended for home gardens and the fresh market, and it is now available in seed catalogs, said Jim Myers, a professor in the OSU horticulture department. "It is the first improved tomato variety in the world that has anthocyanins in its fruit," he said.

Breeding for the antioxidant potential of the purple anthocyanins in the fruit is the most important goal for OSU breeders. "It will lead to a better understanding on how the antioxidants express in tomatoes and may contribute to human health," Myers said. "If you want a really, really purple tomato that can be as black as an eggplant, give Indigo Rose a try," Myers said. "Other so-called purple and black tomatoes have the green flesh gene, which prevents normal chlorophyll breakdown. A brown pigment called pheophytin accumulates and has a brownish color that makes a muddy purple when combined with carotenoids."

Anthocyanins are in the class of flavonoids – compounds found in fruits, vegetables and beverages – that have aroused interest because of their potential health benefits. "They have many varied effects on human health, but while they are powerful antioxidants in the test tube, we don't really know whether they have an antioxidant effect in the human body."

Indigo Rose's genesis began in the 1960s, when two breeders – one from Bulgaria and the other from the United States – first crossed-cultivated tomatoes with wild species from Chile and the Galapagos Islands, Myers said. Some wild tomato species have anthocyanins in their fruit, and until now, tomatoes grown in home gardens have had the beneficial pigment only in their leaves and stems, which are inedible.



OSU vegetable breeder Jim Myers shows the interior of the Indigo Rose tomato. (Photo by Tiffany Woods.)

significantly lower than 'Early Girl' and 'Siletz,' but Indigo Rose produced significantly more fruit than any of the cultivars in trial.

The new tomato is released as an open pollinated variety, and as such, seed saved from self-pollinated plants will grow true and not produce hybrids. "It's also important to know that genetic engineering techniques are never used to develop these lines," Myers said. "These tomatoes are not GMO." **continued on page 5**



Indigo Rose, a truly purple tomato, from OSU's program to breed for high levels of antioxidants. (Photo by Tiffany Woods.)

'Indigo Rose', Continued from page 4

Does the new variety taste good?

"People are passionate about their tomatoes," Myers said. "The purple color draws their interest and because it's extraordinary, people tend to expect impressive flavor as well. It does have a good balance of sugars and acids and tastes just like a tomato. Anthocyanins are essentially tasteless."

Myers cautions not to pick the tomato too soon. Indigo Rose must be allowed to ripen fully for complete development of sugars and acids. It's easy to harvest too early because the usual visual clues won't be there.

The tomatoes will be purple where exposed to light, Myers said, and they tend to have a purple crown. They are ripe when their color changes from a shiny blue-purple to a dull purple-brown. The fruit also softens similarly to regular tomatoes, and the bottom of the tomatoes will turn from green to red when ripe.

Anthocyanin produces in the fruit only where exposed to sunlight. If shaded by a leaf or on the base, the purple pigment does not develop. "However, if you pick an Indigo Rose and expose the non-purple area to sunlight, it will turn purple in about a week," Myers said.

"While other fruits, such as blueberries, have higher concentrations of anthocyanin, tomatoes are consumed practically daily in the United States," he said. The tomato is the nation's fourth most popular fresh-market vegetable behind potatoes, lettuce and onions, according to the USDA.

Cherry tomatoes likely will be the next of several new versions in the Indigo anthocyanin series to be bred within the next three years and are expected to have a good flavor.

Seed company catalogs that carry Indigo Rose include Territorial, Nichols, High Mowing (organic), and Johnnys (organic).

A publication on frequently asked questions about the purple tomato is available online: http://hort.oregonstate.edu/purple_tomato_faq



OSU vegetable breeder Jim Myers
(Photo by Cheryl Brock.)

Journal Highlights

Single Nucleotide Polymorphism Discovery in Cultivated Tomato via Sequencing by Synthesis

Plant breeding is enhanced by the availability of molecular markers for rapid screening and selection in populations. Identification of polymorphic loci in cultivated tomato (*Solanum lycopersicum* L.) has been hampered by limited genome sampling across cultivated types. Whole transcriptome sequencing of six accessions that span cultivated market classes was performed using sequencing by synthesis. Collectively, the transcript sequences and the annotated SNPs provide a resource to facilitate tomato genetics and breeding efforts.

Hamilton, J. P., Sim, S.C., Stoffel, K., Van Deynze, A., Buell, C. R. Francis, D.M., (2012). Single Nucleotide Polymorphism Discovery in Cultivated Tomato via Sequencing by Synthesis. *The Plant Genome*, 10.3835/plantgenome2011.12.0033Vol. 5 No. 1, p. 17-29

Felcher KJ, Coombs JJ, Massa AN, Hansey CN, Hamilton JP, et al. (2012) Integration of Two Diploid Potato Linkage Maps with the Potato Genome Sequence. *PLoS ONE* 7(4): e36347. doi:10.1371/journal.pone.0036347

Position Available

Post-Doctoral Position – Tomato Genetics and Genomics

Domesticated plants differ dramatically from their wild relatives in form and function. Insights into the molecular bases of this diversity improve our understanding of the domestication process and the genes that were selected to outperform their progenitors. The identification of domestication genes also offers opportunities to investigate their role in plant growth and development and how changes in protein sequence or gene expression patterns leads to different plant forms. A post-doctoral position is available to positionally clone several tomato genes regulating fruit shape and size. Owing in part to the publicly available tomato genome sequence, next generation sequencing and genotyping technologies allow researchers to clone domestication genes in rapid fashion. The successful candidate will have experience in one or more areas: quantitative and population genetics, statistics, plant breeding, and/or molecular biology. Candidates with a strong record of scholastic achievements and productivity are particularly encouraged to apply. Salaries and benefits are commensurate with OSU guidelines. Excellent laboratory and greenhouse facilities are available, as well as a service facility that is dedicated to microscopy, gene expression and high-throughput genotyping experiments (<http://oarc.osu.edu/mcic>). For more information go to: <http://www.oarc.ohio-state.edu/vanderknaap/>

References:

Xiao et al. (2008) *Science*, 319:1527-1530; Rodriguez et al. (2011) *Plant Physiol*, 156:275-285; Huang and van der Knaap (2011) *Theor Appl Genet*, 123:465-474; Wu et al. (2011) *Plant Physiol*, 157:1175-1186; Zhang et al. (2012) *Theor Appl Genet*, DOI: 10.1007/s00122-012-1832-8.

Application instructions:

Send via email 1) cv, 2) the names and email addresses of three potential references, and 3) a short statement addressing research interest, future goals and reason for applying to the position. Send application to **vanderknaap.1@osu.edu** and “post doctoral position” in the subject heading. Review of applicants will continue until a suitable candidate is found.

Tomato Breeder’s Roundtable

The Tomato Breeder’s Roundtable (TBRT) started as an informal meeting of tomato breeders in 1955. Over the past five decades the TBRT has become an important meeting for the international tomato research and breeding community. The informal characteristics of the TBRT which has been preserved over five decades, offers a great forum for participants to discuss the latest developments in tomato breeding and associated technology. February 6-8 2013 in Chiang Mai, Thailand. For more information see: <http://www.tbirt2013.com/>



Affordable SNP genotyping facility at Michigan State University

A high throughput Single Nucleotide Polymorphism (SNP) genotyping lab has been set up in the Plant and Soil Sciences Building at Michigan State University . The lab is equipped with an Illumina iScan system and the associated facilities to run Illumina high throughput assays. We have been successfully running the Infinium Assay using the system. In an Infinium assay, a sample can be genotyped with 3,000-1,200,000 SNP markers, depending on the format of the BeadChips. We are making the MSU high throughput SNP genotyping system available to Tomato and Potato Communities for their population genotyping. The following table shows the estimated cost for processing Illumina 24-sample BeadChips. The costs include labor, equipment maintenance and consumables for the lab procedures.

| Cost for processing Illumina BeadChips | | | | |
|---|-------------|----------------|-------------|------------|
| | | | | |
| No. of BeadChips | 2 | 4 | 6 | 8 |
| Total No. of samples for 24-sample chips | 48 | 96 | 144 | 192 |
| Per sample cost | \$27 | \$13.50 | \$10 | \$8 |

This cost is for processing of the Infinium chips only. Infinium BeadChips must be purchased separately from Illumina and shipped to Infinium SNP genotyping lab c/o Dr. Dechun Wang, A499 Plant and Soil Sciences Building, Department



of Crop and Soil Sciences, East Lansing, MI 48824-1325.

There are specific requirements needed when submitting samples. See the lab website: http://potatobg.css.msu.edu/snp_genotyping_facility.shtml for specific instructions before preparing and sending your samples.

The data needs to be processed with Genome Studio software. The software is installed on a computer in the SNP Genotyping lab. If you need a license of the Genome Studio software, you need to purchase the license from Illumina directly (www.illumina.com). A new module of Genome Studio is now available to call up to 5 genotypes.

For more information contact Dr. Dechun Wang, Michigan State University, wangdech@msu.edu or 517-355-0271

Potato and Tomato Beadchips are Available Again!!!!

Due to popular demand and beadpool availability, Illumina has extended the deadline for orders on the SolCAP Potato and Tomato genotyping Beadchips through December 2012.

Illumina will accept orders for the base SolCAP Tomato and potato as well as orders for "Add-on" content for these tools Through December of 2012.

Please contact Illumina at consortiamanager@illumina.com for details. Cindy Taylor Lawley, PhD Scientist Agriculture Consortia Program Manager Illumina, Inc. 25861 Industrial Blvd. Hayward, CA 94545 Tel: [510 670 9478](tel:5106709478) Mobile: [619 379 9360](tel:6193799360) Fax: [510 670 9302](tel:5106709302) Email: clawley@illumina.com Web: www.illumina.com Facebook: www.facebook.com/agconsortia

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Visit us on the web:
<http://solcap.msu.edu>

Calendar of Events:



July 20 - 24, [Plant Biology 2012](#), Austin Convention Center, Austin, TX

July 31-August 3, 2012 [American Society of Horticultural Science Conference](#), InterContinental Hotel, Miami, Florida , **SolCAP Colloquium** will be August 1, 2012 at 2pm.

August 6-8th, [2012 National Association of Plant Breeders \(NAPB\) Annual Meeting](#), University Place, Indianapolis, IN

August 12-16th, [96th Annual Meeting of The Potato Association of America](#), Crowne Plaza Denver International Airport Convention Center, Denver, CO. SolCAP workshop will be held on Aug. 12.

February 6-8 2013. [The Tomato Breeder's Roundtable \(TBRT\)](#) Shangri-La Hotel, Chiang Mai, Thailand.



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