Winter 2013

VitisGen Voice

Mapping the way to the next generation of grapes






Welcome to VitisGen!

Launched in 2011, with a grant from the National Institute of Food and Agriculture Specialty Crop Research Initiative (NIFA-SCRI), VitisGen is a 5-year project that brings together 25 scientists from 12 different institutions across the United States. Their shared goal is to accelerate the development of the next generation of grapes.

"*Vitis*" is the Latin word for vine and is the genus name of all grapevines. Among the different species of grapevines, some originate from Eur-Asia (Old World) and others from the Americas (New World). Grapevines originating in the Americas (e.g. *Vitis labrusca, Vitis riparia*) have strong resistance to pests

"For centuries, grape breeding programs have sought to cultivate better grapes by combining beneficial traits from different varieties."

and diseases, however they tend to produce grapes that are less viable commercially with regard to traits such as taste and aroma. Grapevines with European origins (*Vitis vinifera*) produce more commercially

VitisGen project participants at the project's annual meeting at Cornell University campus in Ithaca, March 22, 2013.

desirable grapes, but they are often susceptible to pests and disease. For centuries, grape breeding programs have sought to cultivate better grapes by combining beneficial traits from different varieties. To do this, plant breeders establish new "crosses" which may result from the pairing of two varieties of the same species (*vinifera x vinifera*), or combine two different species of grapes (*vinifera x labrusca*). By pairing two different species, a new variety can result with advantageous traits form both (e.g. pest resistance and favorable taste). Unfortunately, it can take decades to

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VitisGen Is On YouTube!

Dr. Bruce Reisch, grape breeder at Cornell University and project director for VitisGen, discusses how breeders make crosses, how they choose what parents to use in those crosses, and how VitisGen will make this process more efficient and help to produce improved grape varieties for juice, wine and the fresh market.

How Grape Breeders Make Crosses (http://www.youtube.com/watch?v=z-Pranxd9fw)

develop and release a new grape variety, and it can take even more time for consumers to learn about and accept the variety as something that they would purchase.

VitisGen marks an important advance in traditional breeding programs in that it looks to accelerate discovery and application of new grape varieties with advantageous qualities while also incorporating consumer preferences. In consultation with both the public and private sectors, VitisGen identified three priority traits to focus on: resistance to powdery mildew, increased low temperature tolerance and fruit quality. The scientists who are part of VitisGen remain committed to traditional plant breeding methods. The intention of VitisGen is to identify molecular markers that will help grape breeders in making targeted selections of grapevines favoring the priority traits to include in their breeding programs. VitisGen will make use of new, enhanced technology that will decrease the time, effort, cost and space necessary for developing new grapevines while providing grape breeders with significant information about the grapevines in their programs. VitisGen helps to remove much of the guesswork that has impeded traditional breeding programs, while also reducing costs and increasing favorable outcomes. Through the collaboration of four distinct teams VitisGen seeks to align the priorities of grape breeding projects with the needs of the grape producers and consumers.

VitisGen represents a new model of scientific collaboration. The integration of the needs of multiple interests - breeders, growers, fruit processors and consumers - into a single outcome will result in novel grape varieties that are beneficial to producers, processors and consumers. ■

Five Interactive, Complementary Teams

VitisGen is composed of five interactive, complimentary teams, each with a specific role and set of goals.

Extension and Outreach

The Extension and Outreach Team will foster communication and share VitisGen results with key stakeholders: the grape and affiliated industry partners; plant breeders and geneticists; and the general public and consumers. The Outreach team will work to develop a common vocabulary between the industry, scientists and the public regarding VitisGen processes, technology applications, and favorable traits that can be incorporated into new grape varieties to reduce environmental impacts and improve profitability, while maintaining or improving positive fruit and production characteristics. Workshops and online seminars will be available to assist the transfer of new technologies to other specialty crops, and materials will be posted to eViticulture.org and the 'Grapes' portion of eXtension.org, both of which are designed to provide viticulture education for commercial producers and are accessible to the public. Finally, the team will communicate the project and its findings through a website (http://www.VitisGen.org), and materials for distribution in the general media, such as newsletters or nursery catalogs. They will also produce short videos about the development of new grape varieties, the potential benefits for both growers and the public, and the techniques used in this project.

Trait Economics

The Trait Economics team aims to understand the potential economic impact of the research by the Grape Breeding and Genotyping teams. The team will estimate the economic benefits of each of the identified priority traits. Potential benefits include increased profits for the grape industry, improved fruit quality for consumers, as well as the environmental benefits from the reduced use of pesticides. A series of national surveys of grape researchers, industry, and consumers will be conducted to gather stakeholder perceptions of the priorities that should guide current and future grape research initiatives. The Trait Economics team will also develop and distribute surveys designed to establish estimates of consumers' willingness to pay for certain traits. The goal of these surveys is to improve the alignment of crop breeding goals and methodologies with industry and consumer preferences. By gaining better knowledge about

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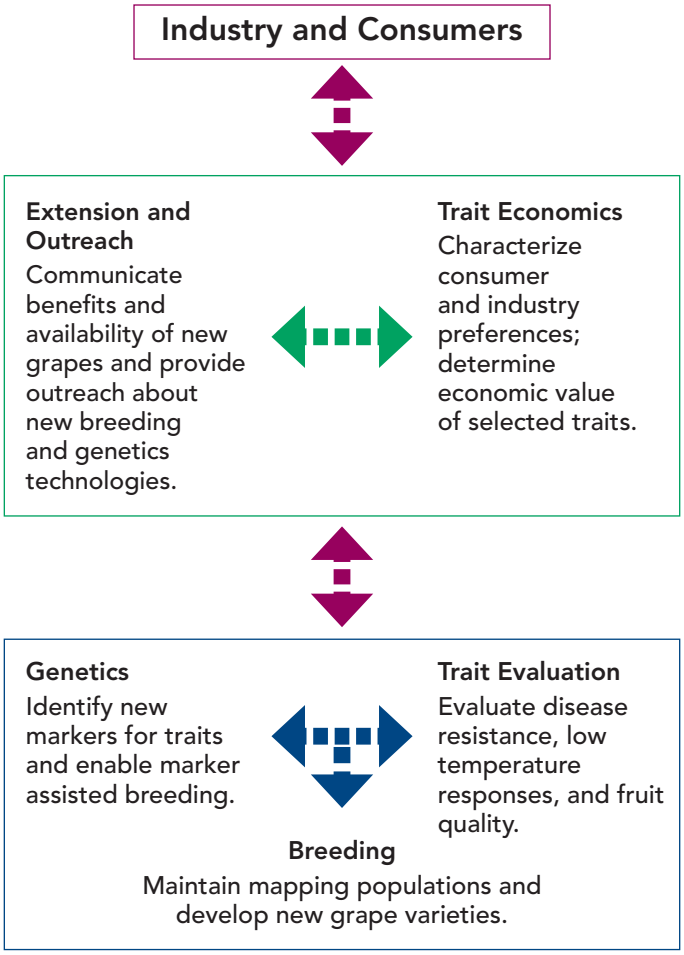

Five synergistic teams work together in a unique fashion, incorporating significant input from both consumers and industry, to develop VitisGen priorities and outcomes.

the desirability of various grape traits, grape breeders can more efficiently translate the development of new traits into marketable cultivars.

Trait Evaluation

The Trait Evaluation team will develop screening protocols to extensively evaluate the priority traits in U.S. grape breeding populations. Each year, the Team will work with breeders to coordinate sample harvests and then process and evaluate samples for relevant traits, such as powdery mildew resistance, chilling fulfillment, freezing tolerance response, aromas, sugars, organic acids, and yeast-available nitrogen (YAN). The team will characterize each priority trait and provide data defining relevant characteristics (e.g. Line A has strong powdery mildew resistance, Line B has minimal resistance). The screening protocols and breeding stocks were selected to provide a broad sampling of available grape germplasm and identify variation in the priority traits. Variation is necessary to identify molecular markers that are relevant to a specific characteristic. These markers will increase the efficiency of production of new, interspecific hybrid cultivars.

Genotyping

The Genotyping team will develop genetic maps of promising grape breeding lines and use those maps to identify DNA markers that are associated with the project's priority traits, as well as other traits important to different regional markets. The Genotyping team assesses samples selected from a wide variety of grapes and gains detailed genetic information. The team employs a new analytical method called Genotyping-by-Sequencing (GBS), and through this new technology, they will develop more information, at a significantly reduced cost, than could be done with previous sequencing methods. In Year 1 of VitisGen alone, the Genotyping team has already used GBS to identify over 25,000 *V. vinifera* DNA markers. Breeders are already using the marker information to identify seedlings with important genes or gene combinations. The Genotyping team hopes to identify over 2000 markers on each of the 19 grape chromosomes.

Breeding

The Breeding team will identify, develop and maintain grape cultivars with advantageous traits. By integrating information gained from molecular markers identified by the Genotyping Team, as well as economic and consumer preference information (via the Trait Economics Team), the Breeding Team will select *existing grape* lines that have positive traits relating to the priority traits. They will also use marker information to identify new germplasm for novel crosses that will enhance existing grape cultivars and expand germplasm collections. The Breeding teams efforts will allow for the development of long term breeding strategies driven by market and consumer preferences and result in a significant reduction in the amount of time, often decades, needed to develop and commercialize grape cultivars. ■

Five Questions with VitisGen Scientist Dr. Bruce Reisch

1. What is your role in VitisGen?

   Bruce Reisch (BR): I am the lead Project Director, a role I share with Lance Cadle-Davidson. I am responsible for coordination of all aspects of the project, and along with Beth Takacs, Postdoctoral Associate and Project Manager, we facilitate communication, collect and distribute reports, communicate regularly with members of the Industry Advisory Committee, and organize annual project meetings.

2. What was the motivation for the VitisGen project?

   BR: The time was right to bring aspects of advances in DNA sequencing technology directly to grape breeding programs across the United States. "Genotyping-by-Sequencing" was developed by one of our cooperating labs (USDA-Ithaca) and was already having a major impact on corn breeding. The expertise existed to apply this same technology to grapevines, so that we could also develop dense maps of chromosomes and locate the most important genes for a variety of traits—including disease resistance, flavor/aroma, and low temperature stress tolerance. In addition, the project allows us to apply existing knowledge of the location of previously identified genes directly to breeding program—relying only upon a DNA sample from young seedlings. Developing new grape varieties is a long term effort—VitisGen brings a great measure of precision and efficiency to the process.

3. What do you see as the most important/valuable outcomes of the project?

   BR: Breeding efficiency—breeders are already able to identify seedlings with a number of desirable traits prior to nursery or vineyard planting. Identification of additional genes controlling traits of interest to breeding programs across the country—grape breeders are interested in a large number of traits controlled by many genes to further the development of rootstocks, table grapes, raisin grapes and wine grapes. We are in the process of identifying genes controlling a very large number of traits of interest.

   Understanding the value of different traits, and the needs of consumers as well as the grape industry—economists and sociologists on the project are helping us with information of great value in determining future directions in grape breeding. Climate is changing; consumer interests are changing; and the industry continues to face challenges in a competitive marketplace. New varieties

VitisGen Vocabulary

Cultivar

A variety of a plant that has been created or selected intentionally and maintained through cultivation.

Genetic map

Also known as a Linkage map. A map that shows the position of known genes, or markers, relative to each other in terms of recombination frequency, rather than a specific physical distance along each chromosome. Genes that are closer to each other are more likely to be inherited together (and not separated during cell division) and are therefore said to be genetically linked. The closer two genes (or markers) are, the lower the recombination events between them will be, and thus the smaller the physical distance between them.

Molecular marker

Also referred to as a DNA marker. An identifiable difference, or variation, in DNA sequence. To be useful, markers must be easily identifiable (by some kind of assay) and polymorphic (have a certain level of diversity).

are needed to respond to many of these challenges and to improve/expand upon the existing market.

Finally—we see great value in communicating with members of the industry and the general public, via our website (www.VitisGen.org), pamphlets, articles generated by our extension team, and through just this type of newsletter that you are now reading.

4. You've chosen to primarily focus on three traits in this project—powdery mildew resistance, grapevines' responses to cold temperatures, and certain fruit quality characteristics. Why those three?

BR: The entire project was conceived through long-term dialogue with members of the national wine and grape industries. The traits chosen were based on both importance to the national industry and feasibility. We know a great deal about powdery mildew and a number of genes for resistance have already been identified. So we sought to expand upon the knowledge base for genes from a variety of species controlling resistance. Powdery mildew resistance is of great importance across the country and around the globe. Fruit quality, and understanding genes underlying both positive and negative aroma components in fruit, is also of importance to all scion breeding projects. Low temperature stress tolerance is primarily of interest to most viticultural areas from the Rockies going east. In addition, breeders are also characterizing traits of interest in their own programs, and using VitisGen resources to find genes controlling dozens of different traits.

5. Have you had any "unexpected" outcomes from the project yet?

BR: Absolutely! Just last week, we found that some of our seedlings from 2012 crosses were actually the result of self pollination, and not cross pollination! This wasn't always the case, but there were some populations where the DNA testing that was done in the spring revealed that, much to our surprise, seedlings in certain crosses had none of the genes from the male parent, but only had genes from the female (seed) parent. In fact, as expected

Grapevines susceptible to powdery mildew have an abundance of infected leaves, which reduce the plant's overall photosynthetic capacity.

from self pollination, these seedlings were very weak and slow growing in our nursery and were being discarded for that reason, too. We also had an unexpected result in the use of the Run1 gene – a strong gene for powdery mildew resistance. When we use a parent with the Run1 gene, we expect 50% of the seedlings to have that gene, too. We chose one parent for 3 crosses in 2012 on the assumption that this parent carried the Run1 gene. After all, its parent carried it, and this one parent was highly resistant to powdery mildew for several years in the field. However, DNA tests came back saying that neither the parent vine nor any of the seedlings carried the Run1 gene. Not quite believing the result, we planted out all of the seedlings in our "no-spray" nursery. What happened? Well the DNA test was more accurate than the breeder. Nearly all seedlings descended from this one questionable parent were susceptible to powdery mildew. We learned our lesson. ■

Publications and Presentations

Recent Publications

Barba P, Cadle-Davidson L, Harriman J, Glaubitz J C, Brooks S, Hyma K, Reisch B. (2013). Grapevine powdery mildew resistance and susceptibility loci identified on a high-resolution SNP map. *Theoretical and Applied Genetics*. September: 1-12. Online version: doi:10.1007/s00122-013-2202-x Alston J, Fuller K, Kaplan J, Tumber K. (2013).

The Economic Consequences of Pierce's Disease and Related Policy in the California Winegrape Industry. *Journal of Agricultural and Resource Economics*. 38(2): 269–297.

Walter-Peterson, H. (2013). Mapping the Way to the Next Generation of Grapes. *Growing Produce*. July 3. http://www.growingproduce.com/article/34642/mapping-the-way-to-the-next-generation-of-grapes

Takacs E, Walter-Peterson H. (2013). VitisGen: Mapping the Way to the Next Generation of Grapes. *Northern Grapes Project Newsletter*. February. http://northerngrapesproject.org/wp-content/uploads/2013/02/2013FebNGPnewsletter.pdf

Fraser R. L. (2012). DNA of the Vine: Grape Goes High Tech. *Growing Magazine*, 10 (8);. http://www.growingmagazine.com/article8441.aspx?highlight=DNA%20of%20the%20vine

Fraser R. L. (2012). Grape Returns to its Wild Past. *Growing Magazine*. 10 (7). http://www.growingmagazine.com/article-8338.aspx?highlight=grape

Selected Presentations

Barba P, Cadle-Davidson L, Reisch B. (c2013). Genetic resistance to powdery mildew in *Vitis rupestris*: Mapping a way to generate durably resistant cultivars. 64th Annual Meeting of the American Society for Enology and Viticulture. Monterey, California, June 26, 2013.

Barba P, Cadle-Davidson L, Hyma K, Reisch B. (c2013). Resistance and susceptibility to powdery mildew: QTL discovery through next generation sequencing of an interspecific cross of grapevine. 9th International Symposium on Grapevine Physiology and Biotechnology. La Serena, Chile. April 21–26 2013.

Kono A, Sato A, Cadle-Davidson L, Reisch, B. (c2013). An improved method to evaluate grapevine downy mildew resistance. Annual meeting of the Japanese Society for Horticultural Science. March 23–24, 2013.

Devkota M, Mathisason K, Ye J, Fennell A. (c2013). Using Matlab to Detect Low Temperature Exotherms in Grape Bud Differential Thermal Analysis Scans. First Annual SDSU Symposium on Biological Research Computing, Brookings, SD, March 8, 2013.

Springer LF. (c2013).Tannin Extractability and Measurements in the Winery. Viticulture 2013, Rochester, NY, February 8, 2013.

Cadle-Davidson L. (c2013). An Update on Grape Cultivar Improvement. Annual Board Meeting of the National Grape and Wine Initiative, Davis, CA, January 28, 2013.

Sacks G L. (c2013). Trials in grape and wine flavor chemistry. Penn State University Food Science Seminar Series, State College, PA, January 17, 2013.

Hyma K, Sun Q, Mitchell S, Acharya C, Londo J, Cousins P, Fennell A, Hwang C F, Lu J, Luby J, Ramming D, Reisch B, Cadle-Davidson L. (c2013). VitisGen: Accelerating grape cultivar improvement. International Plant and Animal Genome XXI. San Diego, CA, January 12–16, 2013.

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