RAVE Goes Underground

This year's RAVE seminar focused on soils and roots, providing a tremendous opportunity to learn about this often neglected portion of the vineyard.

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THIS YEAR'S UC Davis Extension RAVE (Recent Advances in Viticulture and Enology) got a bit dirty. The annual event was held on March 16 at Freeborn Hall. Unlike previous RAVE events, which covered a multitude of topics of interest to the wine industry, this one focused on a more narrow set of topics: soils and roots. A topic that most of us know far too little about, this was a tremendous opportunity for us to get updated on the current research activities occurring below the soil surface.

Several of the speakers discussed work that was being performed within a single vineyard block in Carneros. One would not have thought that there would be so much to talk about regarding one piece of vineyard, but indeed there was. The case study vineyard was a roughly 10 acre Pinot Noir block that was planted in 1991 by a large winery. The vineyard looked to be a poster child for variability, a clear case of "Caterpillar vineyard development," which was all too common at that time and is still in practice, I'm afraid.

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Scraping off hills and filling in gullies creates zones with shallow soil profiles and other areas with deep soil profiles. There have been better methods developed, where topsoil has been removed before grading and then replaced, but in all cases, soil structure that has formed over tens of thousands of years is destroyed. I will step off of my soapbox for now and touch on some of the topics that were discussed at this forum.

SOIL ELECTRICAL CONDUCTIVITY MAPPING

Dr. **Richard Plant**, professor in UCD's Department of Agronomy, spoke about a soil mapping project using sensor technology and GIS tools in conjunction with traditional soil sampling techniques. They used an electromagnetic device that measures apparent electrical conductivity (EC) in the soil to a depth of approximately five feet. Soil EC is complex, but is affected by soil water content and mineral content, to begin with. The sensor, an EM38 from **Geonics**, in Ontario, Canada, was placed (or moved on a sled) throughout the vineyard block, and the apparent EC values were logged along with their GPS locations. They found that the spatial variation of the apparent EC was highly correlated to some soil properties, including sodium, magnesium and soil texture (sand, silt and clay).

The outcome of their research is encouraging, but it should not be inferred that the sensor is a replacement for traditional soil inspections and sampling methodologies. The correlations observed by Plant et al. do not mean that the soil properties can be measured with this sensor. It means that *variability* may be mapped, which itself is a tremendous benefit. The variability maps can be used to direct specific sampling locations or used to interpolate values between point sample measurements. There are several caveats to the technology, such as that it performs best when soil is at field capacity and that the electromagnetic sensor may be interfered with by steel vine stakes.

CORRELATING VINE GROWTH AND SOIL PROPERTIES

Dr. **Jean-Jacques Lambert**, assistant research soil scientist, continued the discussion around how soil properties and vine growth were correlated. He showed that vine size (measured using trunk diameter) was correlated to soil texture as well as to soil mineral concentration, including potassium, calcium and sodium. The correlations he described were significant but not eye-popping. One must consider that soil textural and mineral factors (and other factors) act both independently and together to influence vine growth and development.

Probably one of the most important factors, plant-available water content, was shown to be correlated with soil texture, namely clay content. While not a new discovery, it was important to show how variation in water availability will create variation in vine growth, and with it, management headaches.

Natural variability in available water exists for any piece of land, due to site geology in addition to processes such as erosion. However, Lambert was quick to point out that man-made influences may exacerbate the variability of a site rather than make it more uniform. The most heinous practices include grading of the land and ripping prior to planting. He said that grading of the land truncates soil profiles in the high spots and buries the natural profiles in the (formerly) low spots. Similarly, ripping in the old style of deep cross-ripping destroys soil structure and creates artificial soil horizons, an example of which was shown by Lambert. Newer techniques, such as ripping only along the vine row with winged ripper shanks[1], produce the desired uniformity improvement without destruction of the soil structure.

ROOT PRUNING TO REDUCE VINE SIZE

Getting back to the "management headaches" that I remarked on above, if a vineyard is plagued by variability, it then must be managed. If not managed, the vineyard will never produce wines of high quality as I stated in a previous article[2]. Dr. **David Smart**, assistant professor and program coordinator for this year's RAVE symposium, added to the variability discussion by showing how the variation in soil available water had a measurable effect on vine water status. Some remedial measures were mentioned, including applying cover crops in "mosaics" to reduce vigor in some zones or tillage of cover crops to enhance vigor in other zones.

Smart discussed some work on root pruning of grapevines in order to restrict the volume of soil to selected vines, thus lowering their water status. Ostensibly, the idea would be to prune roots in vigorous regions to limit their growth. He showed that root pruning (simulated by hand and not by a ripper shank) did have the intended effect of reducing water status of the vines and also affected the desired reduction in leaf area. The results of this work are in press with the *American Journal for Enology and Viticulture*. He did stress, however, that this was a drastic proce-

dure and did not recommend that everyone run out and prune roots in vigorous portions of their blocks. Note that this practice has not been tested on a vineyard scale yet with regard to vineyard uniformity improvement.

THE IMPORTANCE OF MYCORRHIZAL FUNGI

Numerous other speakers spoke on topics outside of the realm of vineyard variability and precision viticulture. I cannot, unfortunately, discuss them all within the space of this column. But to continue on my soapbox about restrained soil disturbance during vineyard development, a pertinent presentation was made by Dr. **Kendra Baumgartner**, plant pathologist with the **USDA**. Her presentation was about the beneficial aspects of *arbuscular mycorrhizal* (AM) fungi in vineyard soil. Something that difficult to spell has got to be important, right? Actually, I was surprised at how important they really are.

The AM fungi live in symbiosis with plant roots, extracting carbohydrate from the roots while providing mineral nutrients to the host plant in exchange. The AM fungi send out long hyphae (fibrous masses) into the soil and can creep into pores smaller than those that plant roots can penetrate. Scientists have computed that it requires less energy for a plant to "feed" the AM fungi rather than to invest energy to produce their own root mass required to do the same job.

It is known that AM fungi are useful in taking up micronutrients as well as the immobile macronutrient phosphorous. Baumgartner presented research showing that they are also important for nitrogen uptake. AM fungi also colonize cover crop roots and serve as a "bridge" for nitrogen transfer from the decomposing cover crops to the vines.

Nitrogen, applied in excess and at the wrong times, can be detrimental to good viticulture by stimulating vegetative growth of the vines. But a slow and steady uptake of nitrogen from decomposing soil organic matter, assisted by AM fungi, would reduce the need for supplemental nitrogen applications, thus reducing the risk of over-stimulation of the vines. It seems like a no-brainer that a healthy AM fungal population is essential for a sustainably farmed vineyard.

That seems like a good reason not to "insult" the soil during vineyard development by fumigation. Fumigation sterilizes the soil, at least temporarily, thus eliminating or reducing the benefit that the AM fungi (and other microorganisms) provide to the vines. Fortunately, for those installations where fumigation is absolutely necessary, there are inoculants available that can speed the process of recovering the soil's AM fungal population. Baumgartner cautions that the inoculants are viable organisms prepared by the manufacturer shortly before shipment. The products have a short shelf life, only about one month when properly stored.

If attendance was any indication of success, I'd say that this was the most successful RAVE in recent memory. I expect that most people in the audience left with a renewed sense that soils are not just dirt. **wbm**

1 A. Cass, D. Roberts and M. Bobbitt. "Wing Ripping - Deep Tillage of Soil for Production of Optimum Wine Quality and Environmental Sustainability." *Australian & New Zealand Grapegrower and Winemaker,* 473a:51-59.

2 M. Greenspan. "Taming Fruit Variability." *Wine Business Monthly. December,* 2005. Pp. 44-46

Previous columns:

Avoiding Poor Fruit Set, Mar 2006

Investigating the Relationship Between Yield and Quality, Feb 2006

Hang Time: Wineries and Growers Seek a Common Ground, Jan 2006

Taming Fruit Variability, Dec 2005