Considering Roots

We don't think much about the roots of grapevines. We are so busy fussing over the canopy and fruit it's not easy to get our thoughts into the subterranean sphere but it's just as important as what we can see. In fact, when we talk about vine balance, it's all about what's going on belowground.

Rootstocks are a critical part of the formula for achieving vine balance, performance and pest resistance, and own-rooted vines certainly have their own unique characteristics. But it's amazing how little is understood the vine roots and the rhizosphere given all of our viticulture knowledge.

Dr. David Smart from the viticulture and enology department at UC Davis is trying to illuminate root behavior for us by actually taking pictures of root growth (or lack of it) over time and in the field. He works with Dr. David Eissenstat at Penn State University and Dr. Alan Lakso at Cornell. They use a very clever device called mini-rhizotron that is a clear plastic tube inserted into the ground with a special camera that can actually take images of roots at different depths. Over the past few years he has taken hundreds of thousands of images of roots in action, so to speak.

I got to hear Dr. Smart talk at the Maryland Grape Growers Association annual meeting and will try to summarize some of his key points.

Let's be clear that we are talking about roots growing in an arid climate at the Oakville Research Station of the Department of Viticulture and Enology, UC Davis, in Napa Valley under dry conditions and using drip irrigation. Root distribution has been studied but is not well understood. Nelson Shaulis did some extensive root mapping at Cornell with trench wall profiles and found out that soil impediments like a clay pan will have a dramatic effect on a roots ability to go deep but roots have an equally dramatic ability to find their way through or past some obstacles. Whether rootstocks are shallow or deep rooted, Dr. Smart found they have somewhat similar distributions because the physical characteristics of the soil will have the strongest influence on root growth and distribution. Grapes are deeply rooted compared to many other plants and the roots grow in much the same way as the shoots above – like crazy!

One interesting hypothesis Dr. Smart investigated is whether roots actually redistribute water out of the zone of irrigation. During the day when the vine is subject to evapotranspiration (ET) most of the water goes directly up and into the shoots and leaves where it is needed. But at night when ET slows water is still moving but it will go into roots outside of the wetted

area by moving opposite to the upward direction of evapotranspiration! These roots may actually store water for use during the day when demand is high. These exterior roots will move well into the row middles and beyond!

A trial was set up using Merlot on 1103P, a vigorous stock, and 101-14, a less vigorous rootstock. Using three treatments – no water, 40% deficit ET and 100% deficit ET they looked at root growth through the mini-rhizotrons. In June of 2002 they saw no rootlets growing from a main root, then in 2 weeks there were nice rootlets and in another 2 weeks those rootlets had already begun to lignify. It was quite amazing to observe these images. Rootlets are born and die a few weeks later. The main season for root development is in the late spring around the time when soil temperatures are starting to warm and there's enough canopy for plenty of photosynthesis activity (June 1 in Napa). Leading this with a springtime application (May) is a good time to put down fertilizer. Interestingly, there was no difference in the birth rate of rootlets between the wet and dry zones. Dr. Smart believes this is because of the ability of the vine to redistribute water so readily from the drip zone and other water sources – like a high water table.

Dr. Smart and his colleague Dr. David Eissenstat found phylloxera living on both rootstocks evidenced by the characteristic hook shape they create on new rootlets. He wondered what the louse is doing on these resistant stocks? He thinks that one reason 101-14 may be less vigorous than 1103P is because they carry more phylloxera and become slightly weaker as a result. This is actually a favorable characteristic in Napa because it may help to keep the vigor down on varietals like Merlot that can be very vigorous.

Another interesting outcome was the availability of nitrogen between the two rootstocks. 1103P demonstrated better fermentation rates than 101-14 and it appears they have different nitrogen absorption rates. 101-14 has very little arginine present at harvest, a key amino acid implicated in yeast assimilable nitrogen needed for successful fermentation and also a suspect in the atypical aging problem. Nutrition, roots and water are all closely linked and have direct effects on the vines, grapes and wines that come from them.

Rooting depth of these vines was down to a maximum of 1 meter with a bell shaped curve with maximum roots present at 50cm and most roots occupying a zone from 30-80cm.

Here are some of the key points from his research:

- Grapes have deep and aggressive rooting behavior
- Grape roots redistribute their irrigation water extensively
- Water redistribution seems to enhance the survival of roots in dry soils
- Irrigation has less influence on fine root production than does the season.
- Rootstocks differ widely in their ability to absorb and transport nitrogen

Should roots matter to growers? Why and what can growers do about it? Clearly during the critical vine development phase (years 1-5) it is important to balance canopy and crop with the root system. Do not push the roots past what they are able to supply to the vine. Root distribution, whether own-rooted or rootstock, should be adapted to the soils, expectations for the wine, and if irrigation is used. Phylloxera resistance is paramount for all vines.

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