Root Mapping: An Investigation of Grape Rootstocks Below Ground

By Lisa Morano and W. Mark Kliewer

Rootstock trials are appearing in vineyards all over California. It is urgent to determine how different rootstocks will affect fruit quality when grafted on different scions, grown in different soils or established in distinct regions of the state. However, there is little general information on the root systems of the grapevine rootstocks available to growers. Some belowground studies have been done in other countries, but a replicated investigation of various rootstock root systems in California is distinctly absent. A current study at the UC Davis Oakville Experimental Vineyard may fill such a niche.

Roots are important for not only the uptake of plant nutrients and water, but they serve a substantial support function as well. Roots are also vulnerable to a number of soil pathogens which are difficult to monitor or control from above ground. As with all plants, the root system of grapevines serves vital uptake functions and is susceptible to pests and diseases. Studying the general morphology of the grapevine root system is the first step to understanding the crucial belowground/aboveground vine interactions.

The project hopes to determine if there are any intrinsic differences in the root systems of the seven rootstocks 039-16, 3309, 110R, AXR #1, 5C, 1616 and 420A by directly mapping grapevine roots. After recording the size and location of all roots on the wall of a trench parallel to the vine row, a root map of each vine is created. These maps can then be compared statistically to determine if differences in the root systems are due to rootstock, depth, planting density or soil texture.

With the use of a backhoe, trenches two meters (about seven feet) deep were excavated from vine trunk to vine trunk about 30 centimeters (one foot) into the vine row. A separate trench was created for each of seven rootstocks, for each of two within-row vine spacings (one meter and two meter) and in four separate rows, for a total of 56 trenches. For each trench a one-square-meter grid is placed onto the trench wall. The position and size class of the roots are recorded onto a corresponding data sheet to create a root map. The grid is then moved to the next location on the trench wall.

Lisa Morano (left) and Gerhild Westphal stand in two-meter deep trenches, preparing to record the distribution of grape roots of one of seven different rootstocks being studied at the Oakville Experimental Vineyard in Napa Valley. Morano is a Ph.D. viticulture student at UC Davis. Westphal is a postgraduate researcher from Germany and is assisting on the project.

The six-year-old Cabernet Sauvignon vineyard used for this root study is part of a larger rootstock trial set up to determine the effect of stock, vine spacing and row spacing on canopy microclimate, vine nutrient status, crop yield

- To determine if root vigor (high density, deep distribution or many large roots) correlates with above-ground vigor (high yield or high pruning weight).

This work is currently underway, and it will be some time before soil samples are analyzed for texture and root numbers are condensed to a comparable set of means. However, some interesting trends are already apparent. The rootstock 039-16, which typically has high vigor above ground, appears to also have more roots and larger roots. Less vigorous stocks such as 1616 and 420A have shallower root systems and lower root densities than 039-16. The drip irrigation used during vine establishment and dry periods of the summer did not appear to limit rooting depth. All rootstocks had some roots below one meter and many had roots growing two meters below the surface.

Thick clay strata in the soil seem to limit root growth of all stocks. Root density is unmistakably higher in gravel lenses or patches of soil high in gravel. A change in root density with a change in soil texture at one site does not appear to dramatically alter vine vigor. There are two possible explanations for this phenomenon. First, loose gravel lenses impart little resistance to growing roots but usually represent only a patch of increased root density. Second, a higher root density could reflect a shift in the local root-to-shoot ratio, compensating for a more limited or variable water supply.

Information on the effect of vine spacing on root distribution patterns could assist growers in selecting rootstocks amenable to vineyards with closer spacings. If specific rootstocks are generally found to be more shallowly or more deeply rooted, growers could select rootstocks which, when matched with specific soils, would either help improve or limit vine vigor. Looking for trends in rooting patterns based on the *Vitis* parentage of the rootstocks could also help rootstock breeders select for root systems with specific vigor levels.

In addition to the vineyard mentioned above, the study will be extended to another rootstock trial in the Napa Valley area with different soil types. This should allow any trends in the root systems of rootstocks that are independent of vineyard to emerge. The influence of trellis-training systems on root distribution pattern is also under investigation at UC Davis.

There are two related grapevine root experiments in progress which are independent of the vineyard. A greenhouse study of vines planted in transparent pots is yielding information about root growth rates, branching patterns and initial rooting angle. A field study will compare the native habitats of three *Vitus* species (*Vitus berlandieri, Vitis riparia* and *Vitis rupestris*) which were used to breed most of today's grapevine rootstocks. This research may reveal environmental conditions which could have encouraged specific rooting characteristics through thousands of years of evolution.

Additional studies of rootstock rooting patterns under different soil, climate and cultural conditions are urgently needed to help make decisions of what rootstock to use on specific sites in future plantings. □

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