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Considerations for Monitoring Grapevine Nutritional Status

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As in 2005, we are faced with a cool wet spring. Last year's inclement weather led to a high incidence of Botrytis shoot blight and powdery mildew, so many growers are anxious to enter their vineyards this spring to apply fungicides. As soon as the cool weather passes and fungicide applications have been made, growers should turn their attention to monitoring vineyard nutrition. May is the time that bloom petiole samples should be taken to identify season-long fertilizer needs. With the unusual duration of cold wet spring weather, questions regarding curative approaches for poor growth are often asked, typically focusing on fertilizer rates, timing, and types. Often what is needed is warmer weather, rather than fertilizer, but petiole tissue samples made at bloom can aid in determining what, if any, fertilizer may be needed. Fertilizers are costly and may be a waste of money if the amount or type of fertilizer applied does not meet the vineyard's nutritional need. Monitoring a vineyard's nutritional status during the current season and comparing the data collected with past records gives a good indication of what might be needed.

There are three main reasons to collect grapevine tissue samples for nutrient analyses: surveying, follow-up, and diagnostic. Surveying is used to determine a vineyard's status within or between growing-seasons. Surveying a vineyard each season produces historical data that can then be used to decide fertilizer rates and scheduling. Follow-up sampling can help determine if fertilizer applications, based on the interpretation of the surveys, have met the vineyard's nutritional needs. The third approach helps diagnose deficiencies or toxicities that might present vague symptoms. The benefit of these supplemental analysis improves with data from nutrient surveys, which are the focus of this article.

Soils Role in Grapevine Nutrition

Prior to identifying a vineyard's nutrient status, information regarding site characteristics should be determined. Fertilizer needs, historical data or an annual fertilizer program will depend on a few factors. Soil plays an integral role in a vineyard's long-term health and production. Generally, San Joaquin Valley climatic conditions are uniform but vineyard soils have a wide range from "weak" light soils to "strong" heavy soils. Light soils tend to be low in organic matter, leach nutrients, and have a low water holding capacity. Light soils are represented by coarser-textured sands that favor vertical rather than horizontal movement of water. Heavier soils have the opposite characteristics and on occasion may have reduced water percolation, leading to additional problems. Heavier soils are represented by finer-textured soils high in clay content. To begin identifying a soil type for a particular site the USDA soil survey maps should be referenced. Hardbound soil surveys for each county can be found at National Resource Conservation Service and UC Cooperative Extension offices, local libraries, or online. Online information for California soils can be found at: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. Soil surveys only give general information for the site of interest and a complete soil analysis should be done by a local lab for a more detailed assessment. The best information obtained from a lab soil analysis includes problems related to chemical imbalances or excesses. Problems such as pH (alkalinity and acidity), high salts, cation imbalances (Mg:Ca:K), and high boron levels can be identified through soil analysis prior to vineyard establishment, cautioning a grower as to the need for correction pre- or post-planting. Previous crop history and practices—like deep ripping—will dictate how a particular soil and grapevine cultivar responds to current farming operations, including fertilizer amendments.

Cultivar and Rootstock Role in Grapevine Nutrition

The characteristics of the cultivar planted should also be considered as well as whether the vines will be grown on their own roots or a rootstock. Growing a cultivar on its own roots can be challenging when phylloxera and nematodes are present. These soil pests feed on roots and will considerably reduce water and nutrient uptake, thus reducing plant vigor and yields. There are several rootstocks suitable for raisin, table and wine-grape production in the San Joaquin Valley and growers should consult with UC Cooperative Extension personnel, grapevine nurseries, and certified crop advisers specializing in viticulture to determine the best rootstock(s) for their site. Rootstocks with soil pest resistance should be considered prior to planting a new vineyard. Additionally, rootstocks adapted to a particular soil environment should be taken into account since factors like soil texture, depth, fertility, and chemistry will play a role in nutrient and water assimilation. Own-rooted cultivars and those grafted to rootstocks respond differently to their environment.

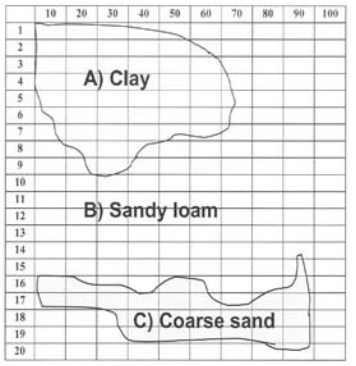

Figure 1. Parcel to be planted to Fiesta. Soil types represented are clay, sandy loam, and coarse sand. The vineyard is 20 rows by 100 vines in each row.

Once factors such as cultivar and soil type have been determined, deciding how a vineyard should be sampled becomes much easier. Samples should represent vineyard blocks that are of the same cultivar or cultivar/rootstock combination. Locations that represent different cultivars, soil types, or vines that are displaying deficiencies, toxicities, weak growth or unknown symptoms should also be sampled separately and compared to samples from "normal" parts of the vineyard.

For example, figure 1 shows a hypothetical parcel of land represented by three different types of soil: A) clay, B) sandy loam and C) coarse sand. Previously planted to grapevines that were flood irrigated, the new vineyard will be planted in the same row direction and flood irrigated.

The cultivar Fiesta is being considered but the grower is not sure if he wants to plant them on their own roots or on a rootstock. Own-rooted Fiesta and Fiesta grafted onto Freedom will differ in their overall vigor and yields when planted to the three soils. Although Fiesta will do well on the clay and sandy loam soils, which make up 75 percent of the vineyard, it will not tolerate any soil pests remaining from the previous vineyard. important characteristics of Freedom rootstock are its drought tolerance, resistance to nematodes and its ability to forage for minerals. However, Fiesta grafted onto Freedom rootstock and grown on soils with adequate nitrogen is prone to excess vigor and poor fruit set if fertilized with nitrogen, and not sprayed with zinc, at pre-bloom to bloom. Freedom's efficiency at foraging for nitrogen is an important characteristic of that rootstock which should be considered when planting a new vineyard. Both scenarios present nutritional imbalances that limit raisin production if not managed properly. This example supports the need for information on cultivar, rootstock and soil interactions and the importance of tissue sampling for monitoring a vineyards nutritional status when planted on different soils.

Plant Tissue Analysis

Once the areas of the vineyard have been characterized for differences, grapevines that represent those differences should be identified on a map, or with flagging tape or some other type of marker.

These plants will be sampled separately each year to determine whether or not their nutritional needs are similar. By understanding the variability in the vineyard, fertilizer applications can be applied as needed which could be more cost effective than simply applying the same fertilizer regime to the entire vineyard. Growers have several choices for acquiring nutritional data including contacting their vineyard consultant, PCA, a reputable lab, or collecting the samples themselves and sending the samples to the lab. Once a good lab is identified, it is a good idea to use the same lab each year because different labs may use a different protocol for determining the contents of certain nutrients. If different labs are used each year, it could be difficult to determine how much of the annual variation in nutrients is due to nutritional status of the vines or to differences in laboratory methods. For a lab in your area contact your local UCCE farm advisor. The following protocol can be used should you choose to collect the samples yourself or assign the job to the person in charge of fertilizer applications. Petioles from mature leaves opposite basal clusters will comprise the tissue sample collected at bloom. Bloom is defined as flower clusters having at least 60-70 percent of the caps removed or detached when the vineyard sites selected for analysis are surveyed. Healthy plants that represent the majority of the vines in the block should be selected for sampling year after year so historical data can be developed. A minimum of 80 petioles from non-shaded leaves should be collected for analysis of macro- and micronutrients and salts of interest. If the cultivar being sampled has small petioles, more than 100 may be needed. Petioles should be washed, patted dry to remove excess water, oven dried at 150°F and transported to a commercial lab for analysis. Some labs may include the collecting and processing in the cost and should be contacted prior to sampling. Most commercial labs will run analysis on many of the macro- and micronutrients (Table 1.) and the results will range in value from deficient to toxic for most elements. Growers who use tissue analysis to monitor for fluctuations in nutrient status in coordination with soil and water analysis will maximize its benefit. Soil and water analyses may only be needed prior to vineyard establishment and then only periodically checked, but the information can contribute to site knowledge and vineyard health.

Table 1. *Guide for grape petiole tissue analysis at bloom.

Nutrient	Units	Deficient (below)	Adequate	Excessive (above)	Toxic (above)
NO_3-N	ppm	350	>500	2,000	8,000
P (total)	%	0.10	0.15		
K (total)	%	1.0	1.5		
Mg (total)	%	0.20	0.30		
Zn (total)	ppm	15	26		
Mn (total)	ppm	20	25	300	2,000
B (total)	ppm	25	30		80
Na (total)	%				0.5
Cl (total)	%			0.5-1.0	1.5

*** Values are guidelines to help identify potential fertilizer needs. Grower experience and vineyard health will determine a vineyard's nutritional requirements. The values are generally acceptable for all varieties with the exception of NO_3–N. Critical NO_3–N levels are based solely on data from Thompson Seedless on own roots.**

The Role of Nitrogen in Grapevine Nutrition

Nitrogen is the primary nutrient that most growers should be concerned with and its availability is better defined when soil, water and tissue analysis are conducted for a specific site. Nitrogen has the greatest effect on vine growth and should be monitored closely. Good information has been developed identifying a grapevine's nitrogen needs, but there are some limitations. In addition to the first two topics previously discussed growers should consider the remaining factors when itemizing the nitrogen budget:

- Soil characteristics
- Characteristics of cultivar and rootstock
- Vine vigor—Nitrogen fertilization should be based primarily on your visual assessment of vine vigor and canopy density (i.e. leaf layers). Vines of high or excess vigor should receive less or no nitrogen, while those of low vigor may respond to increased rates of nitrogen. Use laboratory NO3–N levels to verify observed vine growth and vigor rather than the sole guide to fertilizer practice.
- Soil pests—Pests such as phylloxera and nematodes can severely affect uptake of nutrients and water by compromising root systems. If these pests are suspected, root and soil samples should be taken and sent to a lab experienced in quantifying damage.
- Knowledge of N inputs—Sources from fertilizers, irrigation water, and cover crops can play significant roles in vine vigor and should be accounted for when calculating a vineyards nitrogen budget.
- Tissue analysis—Should be determined to help identify nutrient range for a particular vineyard. It is important to remember that critical values for nitrate-nitrogen (NO3–N) are only established for own-rooted Thompson Seedless. All grape cultivars and rootstocks have inherently different NO3–N levels. Many have normally lower or higher levels than Thompson Seedless. Therefore, nitrogen fertilizer applications for other cultivars should not be based on NO3–N levels. Rather, NO3–N levels should only be used as a general guide to seasonal trends and to help verify excess or low vine vigor situations.
- Irrigation—Drip irrigation has the advantage of placing fertilizer at the root system. Fertigation as it is known, allows the plant to quickly assimilate nutrients that are needed when a grapevines roots are compromised or the soil texture (sandy soils) permits leaching.
- Growers whose vines have sufficient N can anticipate the annual N need of their vineyard by estimating the amount of N removed from the vineyard by harvesting the crop. About 1.46 kg (3.2 lbs) of N is removed from the vineyard in one ton of fresh grapes. Thus, a grower may use his yield of fresh grapes as an indication of the amount of N needing to be returned to the vineyard.

Determining a vineyard's nitrogen requirement can only be determined by assessing the previously mentioned factors. Vineyards of the same cultivar/rootstock combination will react differently when planted at different sites. Historical data and grower experience with the site and cultivar/rootstock combination should dictate a vineyard's needs for nitrogen or other mineral nutrients.

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