Soil Sampling With Respect to Salinity in New Mexico Vineyards

Circular 661

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INTRODUCTION

Excessive soil salinity, which is related to the amount of soluble salts present in the soil, can be a serious yield-limiting factor in New Mexico vineyards. It is therefore important that grape growers monitor soil salinity levels to prevent yield and quality loss. Soil salinity is a concern in vineyards due to grapes' moderate sensitivity to saline environments (Flynn and Ulery, 2011; White, 2003).

Salinity problems affect grapes in a variety of ways:

1. Salinity can induce moisture stress in the grapevines by making it more difficult for them to extract water from the soil. Symptoms of osmotic moisture stress include stunting and slower growth. Eventually the plant may wilt and die.
2. Salinity reduces the photosynthetic rate of grape plants, and this leads to reduced sugar accumulation, smaller berry size, and delayed fruit maturity.
3. Grapes are moderately sensitive to chloride and sodium ions. Sodium and chloride ions constitute some part of the salts in the soil. With high salinity, the sodium and/or chlorides in the soil may lead to toxicity in grape vines. The toxicity manifests as drying and burning of the tips and edges of leaves, which progresses towards the center of the leaves. As toxicity increases, the entire leaf dies and the plants become defoliated.

Salinity, like many soil properties, is often not uniform across any given field, and a base knowledge is required of how variable the soil properties are over the area being managed. This circular will describe the importance of appropriate sampling and vineyard management for salinity, especially where there are significant variations within the field. For more information on soil salinity issues in New Mexico, see NMSU Cooperative Extension Circular 656, *An Introduction to Soil Salinity and Sodium Issues in New Mexico* (http://aces.nmsu.edu/pubs/_circulars/CR656.pdf).

CAUSES OF SALINITY

Before starting to grow vines, it is important that you determine salinity concentrations that are present in different parts of the field, and then make a plan for how to best address any salinity problems that occur spatially throughout the vineyard. Soil types and previous soil management history can have significant impacts on the buildup of salinity in a vineyard. It is not uncommon for a single vineyard to encompass different soil types, which can significantly influence management of soil salinity as well as water and nutrients. Previous field practices, such as amendments applied, rotation systems, and irrigation management, may give rise to soils with different salinity levels. It is also possible for a soil without previous salinity problems to later become saline due to improper irrigation management. Regardless of the reason

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Table 1. Soil Salinity* Measurements at Soil Depths of 0 to 6 and 6 to 12 Inches at Different Sites

	Luna County Site		Doña Ana County Site		Otero County Site	
Salinity Statistics/Field	**0-6 inches**	**6-12 inches**	**0-6 inches**	**6-12 inches**	**0-6 inches**	**6-12 inches**
Average salinity (dS/m)	0.35	0.40	1.17	0.72	8.87	7.75
Maximum salinity measured (dS/m)	0.50	0.82	2.85	1.35	19.54	19.25
Minimum salinity measured (dS/m)	0.25	0.22	0.41	0.47	1.56	0.86
Coefficient of variation (%)	20.90	33.00	53.40	31.70	79.20	92.20

*Salinity measured in 1:1 soil:water slurry.

for salinity, it is possible to control soil salinity using appropriate management strategies, thereby making the soil productive for growth and development of grape vines. A preliminary investigation into how salinity varies over the entire fields of some vineyards was conducted in New Mexico during the 2010 season.

IN-FIELD VARIATION OF SALT ACROSS THREE VINEYARDS

Baseline measurements of soluble salts were performed in three vineyards located in Doña Ana County (2.2 ac), Luna County (16.6 ac), and Otero County (9.4 ac), NM. Geo-referenced sampling (sampling at specific field locations of known geographic coordinates) was conducted to assess the variable nature of soil salinity in selected fields. A hand-held Garmin GPS unit was used to collect the coordinates of sampled locations. When a field is highly variable, collecting a single composite sample to determine a measurement for the whole field will not provide an accurate assessment of the whole field situation. We therefore collected 25 soil samples at geo-referenced spots from the field at two depths, 0 to 6 and 6 to 12 inches (0-0.15 m and 0.15-0.3 m). Collecting samples from different field locations and plotting the corresponding coordinates enabled us to create maps showing variation of salinity within a given field.

The salinity for this study was measured in 1:1 soil:water slurries (i.e., equal weights of soil and water were mixed together and the salinity was measured in the extracted solution that contained dissolved salts). Another way to measure soil salinity is by using the saturated paste extract method, which proves to be the best method for making salinity management decisions (Flynn and Ulery, 2011). The 1:1 soil:water slurry method, however, is quicker and cheaper and can be used to rapidly establish the presence of salinity problems across the different parts of a field.

An electrical conductivity meter is used to measure the salt content of the soil:water mix, and the results are reported in deciSiemens per meter (dS/m); another unit used to express salinity is millimhos per centimeter (mmhos/cm), and salinity measurements using this unit are numerically identical to dS/m. The threshold electrical conductivity beyond which a soil is considered to be too saline for grapevines is 1.5 dS/m using saturated paste extract (Flynn and Ulery, 2011); this value corresponds to about 1.3 dS/m using 1:1 soil:water slurry method (Franzen, 1998). The difference between the 1:1 and saturated paste methods increases as soil salinity increases in magnitude. This salinity threshold for grapes may also depend on the salt tolerance of the chosen rootstock variety. Ehlig (1960) described grapevines as moderately salt-tolerant if chloride injury can be avoided, so the type of salt is as important as the amount. Grapes are similar to cantaloupes and olives in salt tolerance (Richards, 1954).

Table 1 shows the salinity averages at the three different sites and the accompanying statistical analysis, including the mean, minimum, and maximum salinity and the coefficient of variation (CV) of measurements. The CVs are calculated by dividing the sample standard deviation by the sample mean and multiplying by 100. The higher the CV, the more variable the measurement across the field; it is usually better to sub-divide a highly variable field into smaller portions for more effective sampling and management. A CV of less than 15% is usually considered acceptable in agricultural settings, although the lower the better.

Considering the average salinity measurement, the threshold for grapevines (1.3 dS/m) was not exceeded in the Doña Ana and Luna County sites at both soil depths (Table 1). The average salinity of the Otero County site was very high and it exceeded the threshold level by at least six at both depths of measurement (Table 1). Salinity measurements were also very variable across the fields at all sites, with the Otero County site exhibiting the highest coefficient of variability (79% at 0-6 inches and 92% at 6-12 inches; Table 1). Though the variability of salinity was moderately high in the Doña Ana and Luna County sites, it does not matter much with respect to management because the salinity values measured across the fields were mostly below the desired threshold. In Otero County, salinity ranged from 1.56 to 19.54 dS/m at 0 to 6 inches depth and from 0.86 to 19.25 dS/m at 6 to 12 inches depth (Table 1). Due to the high level of field variation experienced at the Otero County site, locating the areas of concern would improve resource management to combat the salinity problem at this site.

ACTUAL FIELD VARIABILITY

We mapped the salinity of the fields at the study sites and classified the salinity levels into four categories: normal, <1.3 dS/m; high, 1.3 to 5 dS/m; very high, 5 to 10 dS/m; and extremely high, >10 dS/m. Maps of soluble salts (0-12 inches depth) were produced for each site and are presented in Figures 1 through 3.

Figure 1 shows that the salinity level of every part of the Luna field was less than 1.3 dS/m and in the normal range for growing wine grapes. In the Doña Ana field (Figure 2), the salinity of about 97% of the field area was less than 1.3 dS/m. Only a small part of the field (3% of the total area) had salinity values exceeding 1.3 dS/m, while no part of the field exceeded 5.0 dS/m. For the Luna and Doña Ana fields, salinity is presently not a major concern. However, the Doña Ana field should be carefully managed by using good-quality irrigation water to prevent any buildup of soil salinity, especially since the maximum salinity measured at this site exceeded the salinity threshold (Table 1).

The Otero field had no area of the field below the salinity threshold of 1.3 dS/m (Figure 3). The proportions of the field in different salinity classes were 28.9% in the high range, 33.7% in the very high range, and 37.4% in the extremely high range (Figure 3). The Otero field presents a serious salinity management problem for growing grapes. In the spring of 2010, visual observations of many vines planted in the Otero field showed symptoms of moisture dehydration due to high salinity, as shown in Figure 4. The farmer had to leach the salts out of the root zone over a long period of time before the plants could recover.

It is important for vineyard growers in New Mexico to manage soil salinity appropriately to avoid yield losses.

STEPS TO IDENTIFY DIFFERENT FIELD ZONES FOR SAMPLING

Appropriate salinity management starts with adequate soil sampling to capture the diversity of soils and management zones in a vineyard. Good visual observations can help identify areas of the field with high salinity—though not always. Such visual observations include:

1. **An area of the field that remains moist when other parts of the field with similar soil textures have dried out.** In this case, the salts may affect the amount of water available for crop use because salts tend to bind more water in the soil. Also, high levels of salinity can lead to toxic accumulations of salts in plant leaves, which impair the function of stomata and reduce the rate of plant transpiration.

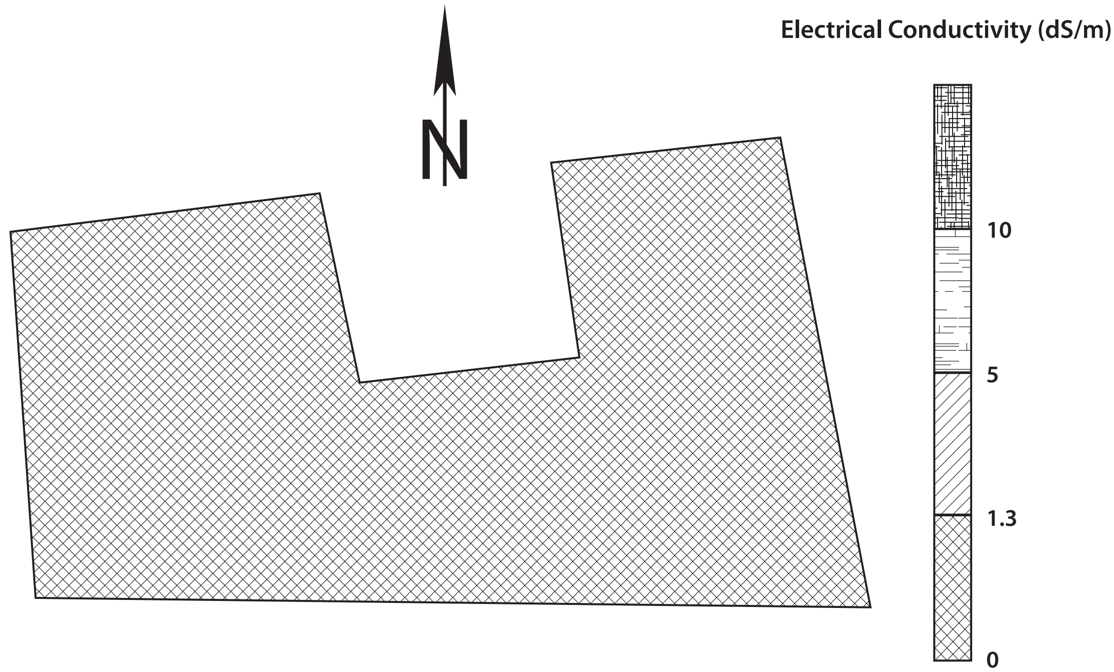

Figure 1. Map of soluble salts (0-12 inches) in the Luna County vineyard.

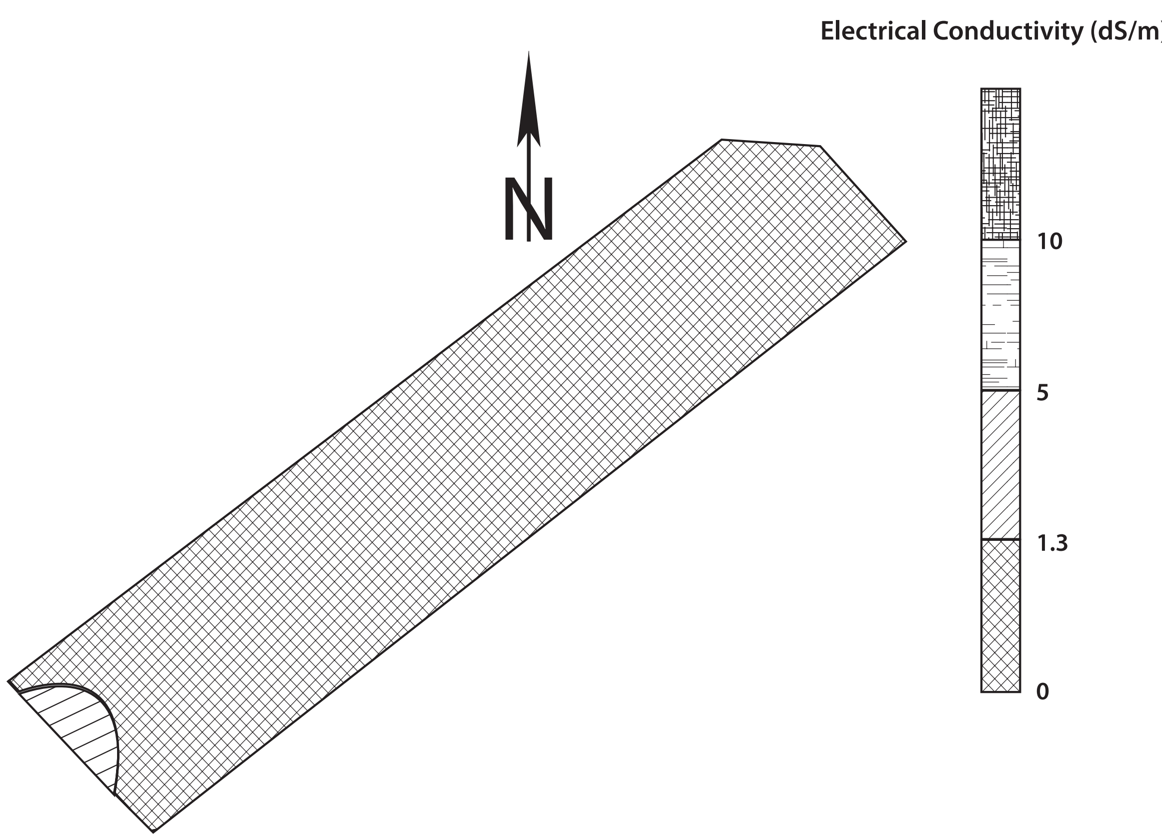

Figure 2. Map of soluble salts (0-12 inches) in the Doña Ana County vineyard.

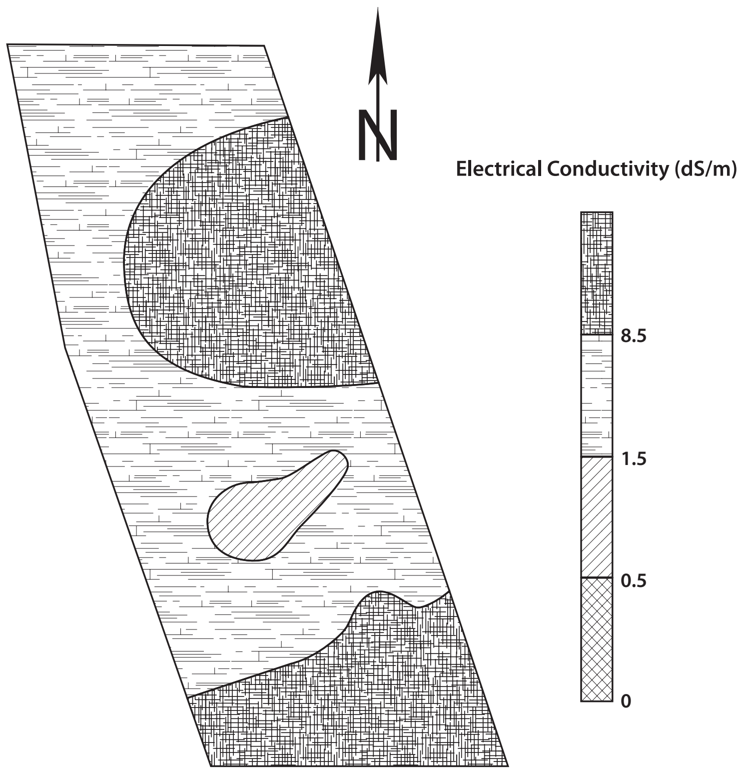

Figure 3. Map of soluble salts (0-12 inches) in the Otero County vineyard.

Figure 4. One of the symptoms of salt stress is drought or moisture stress and defoliation, even when irrigation water is not limiting, as these vines show in Otero County, NM.

2. **An area of the field with white surface crusts.** In this case, the salts have been deposited on the surface after water has evaporated from the surface.
3. **An area that is predominantly covered with salt-tolerant vegetation.** Recognizing salt-tolerant species in a field can be an indicator of salt problems. Examples of salt-tolerant weed species include Russian knapweed, Russian thistle, perennial pepperweed, and horseweed.

While visual observations are helpful, it is still very important to send representative samples to a soil testing laboratory to confirm salinity problems and quantify the salinity level to promote adequate management. Knowing the level of salinity will help you plan how much irrigation water will be needed to leach the salts from the root zone. Coupling an irrigation water evaluation with the soil test will fine-tune the management strategy. Based on the results from the in-field variability study, it is crucial to identify different parts of the field before taking soil samples for salinity analysis. Some important distinguishing characteristics for separating fields into different zones for sampling include:

1. **Soil texture** – Different textures affect the buildup and management of soil salinity. For example, sandy soil textures are easier to leach than clay textures; therefore, more salts tend to accumulate in clay-textured soils. Dividing a field into zones of different textures (if textural differences exist) before collecting and analyzing samples will deliver better results rather than mixing all the samples together from the across the entire vineyard.
2. **Slope** – Slope normally affects the type of soil that is formed in an area. More often, if a field changes in slope, it is likely that the soils on either side of where the slope changes will be different. It is recommended to sample field areas with different slopes separately (if they exist) for more effective management planning.
3. **Management history** – Previous management practices could have significant effects on soil properties, including salinity. Differences occur due to previous crop rotations, tillage methods, irrigation systems, and other cultural practices that were used on the land before vineyard establishment. Such differences should be noted and used as a basis for dividing the fields for sampling, especially at the early stages of vineyard establishment.
4. **Other defining characteristics** – There may be other soil/crop characteristics that farmers notice that may justify dividing the field into different sampling zones. For example, such defining characteristics could include areas with low yields or with poor drainage. Analyzing soil samples from different areas of the field may help farmers establish why different parts of the field are yielding differently, and may also help target salinity management efforts to those field areas with problems, rather than applying effort over the whole field and thus increasing the cost of production.

After establishing different areas to sample, use the following procedure to collect soil samples within each separate unit.

1. Take several (15) core samples at depths of 0 to 6 inches within each zone and place them all into a clean container to form a composite sample of roughly 2 cups. If a core sampler is not available, a hand trowel or a shovel can be used.
2. If the vineyard is already planted, sample in-row, since this is closest to the plant roots and where most irrigation water is delivered under drip or micro-spray conditions.
3. Mix the soil thoroughly; set aside at least 2 to 3 cups of rock-free soil to air dry, and then place into a sealable plastic bag for shipment. Do not leave moist soil on the dashboard of your vehicle.
4. Send the sample to a soil analysis laboratory and request a salinity assessment along with a nutrient profile.

For example, if you have identified three unique areas within your vineyard, three composite samples should be taken, each from the identified area, and the three samples should be properly labeled and sent to the laboratory. Results from the soil analysis laboratory will show the electrical conductivity of the soil for the areas sampled, as well as interpretations of the measured values for management purposes.

REFERENCES:

Ehlig, C.F. 1960. Effects of salinity on four varieties of table grapes grown in sand culture. *Proceedings of the American Society for Horticultural Science*, 76, 323-331.

Flynn, R., and A. Ulery. 2011. *An introduction to soil salinity and sodium issues in New Mexico* [Circular 656]. Las Cruces: New Mexico State University Cooperative Extension Service.

Franzen, D. 1998. *Managing saline soils in North Dakota* [SF-1087 (revised)]. Fargo: North Dakota State University Extension Service.

Richards, L.A. (Ed.). 1954. *Diagnosis and improvement of saline and alkali soils* [USDA Handbook 60]. Washington, D.C.: U.S. Department of Agriculture.

White, R.E. 2003. *Soils for fine wines*. New York: Oxford University Press Inc.

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