SOIL CHARACTERISTICS OF NEW MEXICO VINEYARDS: MANAGEMENT IMPLICATIONS

Robert Flynn, Ph.D.
New Mexico State University
Associate Professor and Extension Soil Scientist, Artesia Ag Science Center.

ABSTRACT

A growing viticulture industry in New Mexico has sparked a need to establish best management practices for the climate and soil conditions present across the state. A survey of soil and water characteristics in established New Mexico vineyards was performed so that appropriate management strategies could be developed and limitations could be identified. Soil nitrogen levels varied from low to high indicating potential problems. Plant tissue testing needs to be included in a phosphorus nutrition program because of the potential effects that myccorhizae fungi can have on plant phosphorus nutrition. Research and extension programs that address water and nutrition management may have the greatest impact on New Mexico's vineyards.

INTRODUCTION

New Mexico grapes occupy a growing niche market in the western U.S. Thirty-one New Mexico wineries/vineyards were listed in 2004 by the New Mexico Land of Enchantment Tourism Department (http://www.newmexico.org/go/loc/food/page/attractions-wineries.html). This project was begun in response to funding from the New Mexico State Legislature and the desire of the College of Agriculture and Home Economics to respond to the needs of New Mexico vineyard managers. Understanding the soil and water characteristics of an area can greatly affect the management practices that are needed to have a high quality vineyard.

METHODS

Vineyard proprietors were contacted to participate in a soil survey of their vineyards during the summer of 2004. Some vineyards requested that they not be identified by name so that data is not associated directly with vineyard name or proprietor. Fourteen vineyard soils were sampled from July 6 - July 10. Individual vineyard characteristics including the type of grape, type of irrigation system, and vine spacing are summarized in Table 1.

Soil samples were taken from the top and second foot of soil. The top foot was analyzed for texture, salinity, nutrients, chloride, boron, calcium carbonate and gypsum. The second foot was tested for texture, nitrate-N, phosphorus, and potassium. Methods are summarized in Table 2. Irrigation water samples were collected at the time of sampling and evaluated for salinity, sodium, nitrate-N, chloride, boron, bicarbonate, sulfate, and potassium.

RESULTS AND DISCUSSION

Soil Texture

Soil texture defines the baseline amount of water that can be plant available. Soil textural classes were quite variable (Table 3). Keith Saxton s Soil Water Characteristics calculator (www.bsysewsu.edu/saxton/) was used to estimate the available water holding capacity of both the surface foot and second foot of soil. Available water holding capacities varied from approximately 0.8 to 1.7 acre-inches. This is a fairly wide range in available water which implies significant differences in set time as well as time between irrigations and overall water management practices.

Large, dense vineyard canopies that result from abundant water and nutrient availability are associated with reduced fruit sugar, high acidity, and poor color (Jackson and Lombard, 1993, Dry and Loveys, 1998). It is generally accepted that some amount of water and nutrient deficit are beneficial for grape composition and wine quality as long as the deficits are not too severe Keller, 2005). Established vineyards may consider techniques such as partial root zone drying to help improve water use efficiency. Partial root zone drying is a technique that keeps half the grape root zone well watered and the other half is allowed to dry. Water savings of up to 50% have been documented with this method without significant effects on grape yield or quality (Pudney and McCarthy, 2004). In an experiment with Chardonnay vines, a full profile was described as at field capacity to a depth of 60-cm. First irrigations usually began 16 to 31 days after flowering depending on soil moisture.

Nutrients

Grape plants respond strongly to nutrient supply. Vine vigor can be controlled by the presence of nitrogen as well as other nutrients (Rantz, 1991; Conradie, 2005). Nitrogen content of the sampled soils was highly variable (Table 4). Nitrogen deficiency can trigger plant responses that are similar to water deficit conditions. Leaf expansion is particularly sensitive to nitrogen supply. Deficit nitrogen, however, may induce more root growth (Keller and Koblet, 1995). Abundant nitrogen can sometimes decrease phosphorus uptake (Spayd et al., 1993).

Phosphorus nutrition in grape plants is strongly affected by mycorrhizae fungi (Schreiner, 2005). Low P soil test levels may not translate to low tissue-test P levels. The management practices that promote mycorrhizae fungi should include cover crops and no tillage. Adding phosphorus sources to the soil may decrease the symbiotic relationship between the grape plant and the fungi. Insufficient phosphorus may also restrict Mg transport in the xylem tissue which can lead to Mg deficiency symptoms. Plant tissue testing should be used to evaluate the need for additional fertilizer P.

NMSU s routine procedure is to extract potassium with water, not neutral ammonium acetate. There is a wide range in water soluble and exchangeable potassium in the sampled vineyards (Table 4). Water soluble potassium may be a better predictor for the need of potash fertilizer for grape production, but not necessarily. The role of potassium in the plant is extremely important for maintaining electrical charge balance at the cellular level especially during periods of cell expansion (Keller, 2005).

Soil pH, salinity, lime, and gypsum

Soil pH varied from 7.1 to 8.2 (Table 5). Much of the soil pH levels in New Mexico are buffered against change by the presence of lime. Lime levels in the sampled soils varied from 1.5 to 8.4 percent (Table 5). All of this lime would need to be neutralized before the soil pH could be lowered. Unfortunately, irrigation water containing bicarbonate can contribute to the lime content of soil and further prevent changes in soil pH. Another parameter related to salinity and is important to grape production is the soil chloride level. Chloride should not exceed 20 me/L in order to avoid root stock injury (Table 5).

There were three soils in our survey that were classified as saline (Table 4). Soil gypsum however, affects the interpretation of the soil electrical conductivity. The highest salinity may have a slightly lower effect on grape production due to the effect that gypsum has on measured soil salinity. As a word of caution it is important that soils be tested for salinity using the saturated paste method. Table 5 demonstrates the difference between the two methods and highlights the fact that saline soils may not be identified when 1:1 soil:water extracts are used.

The research and extension needs for vineyard management are many. Water and nutrition management coupled with green floor covers are areas that may have the most potential. Vineyard floor vegetation is desirable for many reasons but needs to be managed carefully to minimize competition during critical periods. Water and nitrogen management are particularly important to manage with cover crops. New Mexico vineyard managers should not ignore the importance of plant and soil testing in managing their crop.

REFERENCES

Conradie,W.J. 2005. Partitioning of mineral nutrients and timing of fertilizer applications for optimum efficiency. *In* The Proceedings of the Soil Environment and Vine Mineral Nutrition Symposium. P. Christensen and D.R. Smart (Eds.) pp 69-81. American Society of Enology and Viticulture, Davis, CA

Dry, P.R., and B.R. Loveys. 1998. Factors influencing grapevine vigour and the potential for control with partial rootzone drying. Aust. J. Grape Wine Research 4:140-148.

Jackson, D.I., and P.B. Lombard. 1993. Environmental and management practices affecting grape composition and wine quality: A Review. Am. J. Enol. Vitic. 44:409-430.

Keller, M. 2005. Deficit irrigation and vine mineral nutrition. Am. J. Enol. Vitic. 56:267-283.

Keller, M. and W. Koblet. 1995. Dry matter and leaf area partitioning, bud fertility and second season growth of *Vitis vinifera* L.: Responses to nitrogen supply and limiting irradiance. Vitis 34:77-83.

Pudney and McCarthy, 2004. Water use efficiency of field grown Chardonnay grapevines subjected to partial rootzone drying and deficit irrigation. *In* IVth IS on Irrigation of Hort. Crops. R.L. Snyder (Ed.). Pp. 567-573. Acta Hort 664.

Rantz, J.M. (Ed.). 1991. Proceedings of the International Symposium on Nitrogen in Grapes and Wine. American Society for Enology and Viticulture, Davis, CA.

Schreiner, R.P. 2005. Mycorrhizae and mineral acquisition in grapevines. *In* Proceedings of the soil Soil Environment and Vine Mineral Nutrition Symposium. . P. Christensen and D.R. Smart (Eds.) , pp. 49-60. American Society of Enology and Viticulture, Davis, CA

Spayd, S.E., R.L. Wample, R.G. Stevens, R.G. Evans, A.K. Kawakami. 1993. Nitrogen fertilization of White Riesling in Washington: Effects on petiole nutrient concentration, yield, yield components, and vegetative growth. Am. J. Enol. Vitic. 44:378-386.

Table 1. Vineyard characteristics as noted during sampling from July 6 - July 9, 2004.

Irrigation	**Vineyard Age/Type**	**Cane Distance, size, Trellis space**
Drip	Cabernet Sauvignon	6 ft between vines, 10 ft between trellis. Soil level stem diameter 3.75-inches
Flood	**Cabernet Sauvignon with rootstock of 5BB Kobber Berhandieri X Riparia**	6 x 10. 1.25" graft on a 2" rootstock
Drip	Cabernet Sauvignon	5 x 11. 1.5" graft on a 3.5" rootstock
Drip	11 year old Cabernet Sauvignon	7 x 12. 2" graft on a 5" rootstock.
Drip	4 year old Cabernet Sauvignon	1 meter x 3 meter. Graft is 1.5" on 2 inch stock.
Drip	5 year old Cabernet Sauvignon	5 x 9. 2-inch rootstock.
Drip	15 year old Baco Noir	6 x 10. 2-inch rootstock.
Drip	Baco Noir	2-inch graft on 3.5 inch rootstock.
Drip	Merlot and Cabernet Sauvignon	7 x 7. 1.5-inch rootstock.
Drip	4 year old Reisling	6 x 7. 2.5 inch rootstock
Drip	11 year old Muscat Canelli	5 x 9. 2 inch graft on 7-inch rootstock.
Flood	4 year old Leon Melot	6 x 10. 1.5 inch graft on 4 inch rootstock.
Flood	21 year Leon Millot	6 x 10. 1.5 inch graft on 4 inch rootstock.
Drip	20 year old Reisling	6 x 10. 1.25 inch graft on 9 inch rootstock

Table 2. Soil test procedures used on samples collected from New Mexico vineyards.

Soil Parameter	Procedure
Texture	hydrometer
pH	saturated paste and 1:1 soil:water extract
e.c.	saturated paste and 1:1 soil:water extract
SAR	exchangeable Ca, Mg, and Na
Nitrate-N	Water extractable
Phosphorus	Sodium bicarbonate extractable
Potassium	Water extractable and ammonium acetate extractable
Micronutrients	DTPA extractable
Boron	Hot water soluble
Organic Matter	Loss on ignition
Calcium carbonate	Decomposition in acid

Table 3. Soil texture and estimated field capacity water content.

Soil Series	Textural Class		Field Capacity	
	0 - 12"	12 - 24"	0 - 12"	12 - 24"
			inches/foot	
Largo very fine sandy loam	ash	ash	0.75	
Harkey loam	loam	silt loam	1.70	1.71
Mimbres silty clay loam	clay loam	clay	1.33	1.20
Maricopa sandy loam	loamy sand	silt loam	0.94	1.10
Dona Ana sandy clay loam	sandy clay loam	sandy clay loam	1.32	1.19
Mojave sandy clay loam	sandy loam	sandy clay loam	1.11	1.16
Glendale clay loam	clay	sandy clay loam	1.53	1.05
Bluepoint sandy loam	loamy sand	loamy sand	0.87	0.87
Tesajo-Millett gr. sandy loam	sandy loam	sandy loam	1.61	1.17
Vinton sandy loam (1)	loamy sand	loamy sand	0.80	0.81
Vinton sandy loam (2)	sandy clay loam	sandy cl	1.08	1.03
Cundiyo gravelly sandy loam	sandy clay loam	sandy loam	1.41	1.24
Manzano fine sandy loam	sandy loam	sandy loam	1.30	1.29
not surveyed	sandy loam	sandy loam	1.06	1.06

Table 4. Soil test nitrate-nitrogen (NO_3-N), phosphorus, potassium, sulfate-S and organic matter.

Soil Series	Nitrate-N		P	P	K_{water}	K_{exch}	$K_{water+exc}$	SO_4-S	O. M.
	0-12"	12-24"	0-12"	12-24"	0-12"	0-12"	12 - 24"	0-12"	0-12"
	mg/kg								%
Largo very fine sandy loam	76.6	63.7	15	1	105	137	173	523	1.0
Harkey loam	10.3	22.0	25	11	89	250	270	137	0.8
Mimbres silty clay loam	17.0	15.4	8	4	99	502	485	129	1.6
Maricopa sandy loam	1.6	0.6	11	6	159	414	527	3	0.4
Dona Ana sandy clay loam	16.9	4.2	8	4	118	393	383	13	1.0
Mojave sandy clay loam	33.5	16.8	22	12	252	400	505	386	0.4
Glendale clay loam	4.0	1.1	2	1	40	418	235	55	2.1
Bluepoint sandy loam	1.1	0.6	3	1	74	11	115	5	0.3
Tesajo-Millett gr. sandy loam	3.8	2.1	80	61	76	269	277	17	2.8
Vinton sandy loam (1)	9.4	3.4	18	5	168	281	296	49	0.3
Vinton sandy loam (2)	1.2	1.0	8	4	40	243	245	27	0.8
Cundiyo gravelly sandy loam	7.3	8.1	7	2	43	280	188	6	1.1
Manzano fine sandy loam	4.1	1.4	56	12	73	219	211	8	1.0
not mapped	7.2	13.1	22	8	139	445	469	8	0.6

Table 5. Soil pH, salinity, gypsum and lime content.

Soil Series	pH_{sat}	$pH_{1:1}$	$E.C._{sat}$	$E.C._{1:1}$	SAR_{sat}	Na^+	Cl^-	Boron	$CaSO_4$	$CaCO_3$
			mmhos/cm			me/100 g		mg/kg	%	%
Largo very fine sandy loam	7.4	7.3	7.21	3.26	2.7	1.64	0.05	0.52	1.42	8.4
Harkey loam	7.8	7.8	4.22	2.23	5.5	2.15	3.88	1.52	0.15	5.4
Mimbres silty clay loam	7.5	7.6	3.23	2.48	1.7	0.70	0.81	0.32	0.68	3.3
Maricopa sandy loam	8.1	8.3	0.58	0.28	2.1	0.20	0.05	0.36	0.00	1.8
Dona Ana sandy clay loam	7.9	8.2	0.97	0.66	2.3	0.35	0.12	0.29	0.01	3.0
Mojave sandy clay loam	7.4	7.5	6.07	2.84	10.4	4.18	1.08	1.87	0.90	1.6
Glendale clay loam	7.9	7.9	1.35	1.10	4.3	0.68	0.25	0.95	0.06	5.9
Bluepoint sandy loam	8.2	8.7	0.71	0.34	4.6	0.47	0.12	0.68	0.01	5.9
Tesajo-Millett gr. sandy loam	7.1	7.3	1.47	0.84	1.5	0.39	0.29	0.87	0.04	7.2
Vinton sandy loam (1)	8.1	8.3	1.18	0.71	4.2	0.86	0.39	0.74	0.04	1.5
Vinton sandy loam (2)	8.0	8.2	0.88	0.64	1.3	0.26	0.10	0.55	0.03	3.9
Cundiyo gravelly sandy loam	8.0	8.1	0.46	0.43	0.6	0.08	0.05	0.29	0.01	5.8
Manzano fine sandy loam	8.0	8.0	0.79	0.46	0.4	0.07	0.04	0.96	0.01	2.0
not mapped	7.9	8.3	0.41	0.51	2.0	0.32	0.12	0.90	0.01	2.5

PROCEEDINGS
OF THE
WESTERN NUTRIENT
MANAGEMENT CONFERENCE

Volume 7

MARCH 8-9, 2007
SALT LAKE CITY, UTAH

Program Chair:
John Hart
Oregon State University
Corvallis, OR
(541) 737-5714
john.hart@oregonstate.edu

Publicity Chair:
Richard Koenig
Washington State University
Pullman, WA
(509) 335-2726
richk@wsu.edu

Coordinator:
Phyllis Pates
International Plant Nutrition Institute
Brookings, SD
(605) 692-6280
ppates@ipni.net