The Micronutrient Status of Grapevines at the Messina Hof Vineyard

Prepared for
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by
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Attached you will find my final report entitled "Micronutrient Status of Grapevines at the Messina Hof Vineyard".

The purpose of this report is to explain the appearent micronutrient deficiendies which appeared in the Messina Hof Vineyard during the 1984 growing season.

It appears that the chlorosis was caused by new cultural practices which cause root damage.

Sincerely,

Cecilie Siegel

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Micronutrient Status of Grapevines at the Messina Hof Vineyard

by

Cecilie Siegel

Abstract. Texas has recently reentered the grape industry. A problem that confronts prospective vintners in Texas is that our soils have nutrition problems, especially the micronutrients. These deficiencies have led to reduced crop yields on the defective vines and therefore lower profits for the grower. The study was conducted at Messina Hof Vineyard near Bryan. The vines exhibited the classic Zn and Fe deficiency symptoms. Five varieties were tested; Champanell, Black Spanish, Ruby Cabernet, Chenin Blanc and Lake Emerald. I used leaf petioles for tissue analysis, soil testing was not used. My plan of work included; visual inspection, tagging the vines, taking petiole samples, collecting harvest data and some lab work.

The chlorotic vines on the average produced less total yield than did the nonchlorotic vines. I could find no correlation between the incident of chlorosis and the ions which I tested. This indicates it was a temporary deficiency which had corrected itself by the time of sampling. Last spring Messina Hof obtained a new rotary grape hoe and there was some evidence of damage to the roots. The damage occured early in the season and that would have an influence in the amounts of nutrients the plant was able to take up. There was a direct correlation between root damage, chlorosis and yield. The exception was Ruby Cabernet which showed no signifigant difference. Ruby Cabernet was a very shy producer and is notorious for exhibiting Fe chlorosis readily. Lake Emerald did not produce.

This experiment did include two visual inspections which were subjective. There is a possibility that micronutrients could have been applied and not recorded. This would have been responible for the inconsistancy seen in the ion concentrations found in tissue analysis.

The reduced yield and chlorosis were caused for the most part by damage done to the roots by the new cultivation practices. I futher suggest that more care should be taken, when using the grape hoe, to disturb the roots as little as possible.

assayed "total" no "active" nutrient component, where these types of analysis results are typical

Micronutrient Status of Grapevines at the Messina Hof Vineyard

Additional index words: American Hybrids; 'Champenell', 'Lake Emerald', *Vitis vinefera:* 'Black Spanish', 'Ruby Cabernet', and 'Chenin Blanc', ~~automatic~~ absorption spectroscopy, inductively coupled plasma, leaf petiole analysis, ~~refractometer~~, micronutrients, nutrition

Background. There has been little research done on the nutrient uptake of grapes in Texas. Nutrition problems, especially micronutrients, are commonly seen on the calcarous soils in Texas. Micronutrients are essential elements which are required by the plant in very small amounts. If Texas grape growers are to compete with California and European growers, these problems must be resolved. At Messina Hof vines exhibiting micronutrient deficiency, symptoms appear sporadically in the vineyard. These deficient vines also experience reduced yields.

Purpose. The purpose of this study is to undertake experiments to determine the micronutrient uptake of grape cultivars using inductively coupled plasma spectrophotometry.

Scope. The study is limited to determining what causes the appearant micronutrient deficiency symptoms which appear in a random pattern at the Messina Hof Vineyard. The health and vigor of each vine was determined by two visual inspections; the first on 26 June 1984, the second on 8 March 1985; leaf petiole analysis, Brix (a measure of soluable solids), total yield, bunch and berry weight at maturity. The results of this

Style not following major refereed journals in field study will enable Messina Hof to correct some of the problems they are experiencing.

Soil testing was not used. According to Winkler, it has been shown that soil analysis is not an accurate method of determining plant nutritional needs for perrennial crops, especially deep-rooted ones such as vines and trees (11, p.431). Instead, leaf petioles will be used in tissue analysis. Petioles are the best indicator of the nutritional status of grapevines.

maybe not the "best" tool, but still would have been easy to conduct & would have yielded valuable information. At least pH & soluble salts should have been measured.

Summary

Difference between purpose on p1. & objectives on p.2

Objective. My objective is to establish standards for healthy, productive vines growing on calcarous soils in Brazos County.

Rationale and Significance. Using inductively coupled plasma spectrophotometry I determined the amounts of micronutrient the plant had taken up. The health of the vine was determined by visual inspection, yield, Brix and berry size. By correlating this data I was able to determine the cause of some of the damage they experienced.

Project Discription

Methods.

Tagging. On 26 June 1984 I tagged the vines with metal tags, indicating the row and vine number, and blue "flag" tape. Tagging in this manner was helpful in locating the test vines during harvest. At that time I noted the vines which were chlorotic and which appeared healthy.

Petiole sample. Leaf petiole samples were taken on 9 and 10 July. Depending on the size of the petiole between 15 an 25 petioles were taken per vine. The petioles were taken from leaves adjacent the first fruiting cluster. According to Winkler the location on the shoot is of the utmost importance when taking petiole samples ~~(11, p.431).~~ ~~Dr.~~ Stockton explained that petioles should be gathered from leaves adjacent to fruiting clusters ~~(10).~~ This provided the .5 grams of dry matter needed for nutrient analysis.

Harvest. The Chenin Blanc was harvested on 30 July. The Black Spanish, Champenell, and Ruby Cabernet were harvested 7 August. At harvest the grapes were bagged and tagged by vine number. The total yield, Brix, bunch weight and berry weight of individual vines was recorded. One bunch, "typical" of each vine, was selected and the weight was recorded in grams, then all the berries were counted. This was used to determine the average berry size each vine produced. To insure accuracy Brix was taken in the field with a hand held refractometer immediatly after picking. These results are listed in Table 1, ~~"Results of Harvest on Grapes at the Messina Hof Vineyard, located in~~ the Appendix.

Lab Work. ~~With the assistance of Lawrence Sistruck~~ the dried petiole samples were prepared for digestion by the proceedure utilized in the Nutrition Research Plasma Emission Lab in the Horticulture Department at Texas A&M(7). The dry petioles were ground to pass a 20 mesh screen. This prepares the dry tissue for predigestion. One half gram (within 5%) of the ground plant material was placed in a 75 ml volumetric digestion tube. Ten ml of concentrated reagent grade nitric acid is added and allowed to predigest for 24 to 48 hours. The tubes are then placed on a heating unit at 300°C for 30 miniutes, or until the volume reaches approximately 3 ml. After cooling for 5 to 10 minutes 1.0 ml of reagent grade perchloric acid 72% and 0.5 ml of reagent grade sulfuric acid is added and the tubes are returned to the heating unit at 300° C until 2-3 ml remains. After that mixture is cool and additional 5 ml reagent grade nitric acid is added and heated again until 2-3 ml remains. Once this material has cooled, distilled water is added to bring the volume to 75 ml then mixed throughly. A 25 ml specimen of each sample is then placed in storage bottles. These specimens will be used to perform the micronutrient analysis.

Samples were to be tested using the atomic absorption spectroscopy (AAS). This method involves the use of cathode tubes which needs to be placed in the AAS 2-3 days prior to testing. A different cathode tube is needed for each element. Instead of using the AAS for analysis as planned, Lawrence Sistruck that I use the Horticulture Department's new Inductively Coupled Plasma (ICP) spectrophotometer which had been installed in the lab during the week of 12 November. According to Lawrence, the ICP is faster and a more acurate method of tissue analysis than the AAS(7). The ICP can analyze all seven elements simultaneously while the AAS can only analyze one element at a time.

The ICP atomizes the sample or breaks it into an extremely fine mist. The sample is then heated. This allows the electrons to become excited. During this stage, the temperature can reach 8,000° Kelvin. The sample doesn't actually burn but instead forms a plasma which glows. A plasma is the fourth stage of matter; the others being liquid, solid, and vapor. As the plasma glows and the electrons are stripped off the sample, they bounce around an enclosed gold-lined chamber where the wavelength is measured.

Once the testing began the capillary tube which channels the alliquoit into the ICP became clogged. Grape petiole samples are high in protein; and the undigested protein accumulates in the tube. Lawrence contacted the designer of the capillary tube concerning this apparent malfunction. It was suggested that hydrofluoric acid be injected into the tube between each sample. This dissolves the protein and allows the remainder of the tests to go smoothly. Using this procedure, all of the tests were run and completed on 26 November 1984. The results of these tests are located in Table 2, Petiole Analysis located in the Appendix.

Root Inspection. On 8 March a visual inspection of the root was made to determine it there was any appearant damage. – how measured damage?

Sources.

Interviews and Presentations. Dr, Hanna advised me on the choices of varieties to be tested, obtained all the facilities and equipment needed and has provided me with the benifit of his years of experience (4).

Lawrence Sistrunk instructed me on laboratory techniques that I was unfamiliar with (7).

In a presentation to the Texas Grape Growers Association at their Annual Conference, Dr. Stockton talked extensively on proper proceedure for obtaining petiole samples and stressed the need for research of this type in Texas (10).

acknowlegments

Written articles. In Winkler's chapter on fertilizer in General Viticulture I found the proceedure for taking petiole samples and the reason that petiole samples are used as opposed to soil samples when determining the nutritient status of perrennial crops (11).

In their article "Causes of Vine Chlorosis Under Field Conditions", published in *Zeitschrift für Pflanzenernährung und Bodenkunde*, Booss, Kolesch and Hofner find that higher concentrations of Fe, Mn, Zn, Cu and P were found in chlorotic plants as opposed to nonchlorotic ones (1).

Perret and Koblet found that concentrations of 1 ppm ethylene in compacted soil could cause Fe stress in grapevines (6).

Gubareva, Akatnova and Aleksandrova find that high concentrations of Ca in the soil will cause iron deficiency (3).

Means. Lawrence Sistrunk, Lab Technician, in charge of the Nutrition Research Emission Laboratory in the Horticulture Department at Texas A&M, granted me the use of their facilities. They are equipped with an explosion proof hood which is washed from the roof down after each use. This prevents perchloric acid chrystals from accumulating and exploding. They have a Technicon BD-40 Heating Unit with capabilities of handling 40 samples simultaneously. The ICP spectrometer and all neccessary glassware was at my disposal.

The University's Undergraduate Fellowship program provided funds for all reagents necessary to complete the experiment.

Overall Appraisal

A positive correlation was found between treatment and yield. This can be seen in Table 3.

TABLE 3: **Average Yields of Vines-Chlorotic vs. Nonchlorotic**

Variety	Chlorotic (in pounds)/vine?	green ~~Nonchlorotic~~ (in pounds)/vine?	Decrease in yield(%)
Black Spanish	13.1	22.8	42.5
Champanell	5.1	5.9	13.6
Chenin Blanc	5.2	9.0	42.2
Lake Emerald[1]			
Ruby Cabernet	2.1	3.5	40.

[1]Lake Emerald did not produce

Chlorotic vines produced less total yield than did nonchlorotic vines, indicating a deficiency early in the season when the deficiencies were exhibiting themselves. There was no correlation between the incident of chlorosis and the ions tested. Leaf petioles were collected about one month after visual inspection indicating that it was probably a temporary deficiency which had corrected itself by the time of sampling. Overall there was a slightly higer concentration of Fe, Mn, and Cu found in the chlorotic vines vs. the nonchlorotic vines. In their article Causes of Chlorosis Under Field Conditions published in 1982, Booss, Kolesch and Hofner state that tests run in German fields found relatively higher amounts of Fe, Mn, Zn and Cu in chlorotic vines vs the nonchlorotic ones. They showed a 20% difference betrween the two groups. The test that I conducted did not show that amount of difference and I began searching for some other event that could have caused the differences.

Chlorotic samples often are poorly correlated with nutrient content when measures total content as you did. Also, often see higher content because of internal precipitation & accumulation in chlorotic tissue

In the spring of '84 Messina Hof obtained a rotary grape hoe and there was some evidence of damage to the roots. On 8 March 1985 another visual inspection of the vineyard was conducted, this time to check for root damage. There was damage evident throughout the vineyard but first few rows showed mild to severe damage, without exception, to every vine. The grape hoe had been used in vineyard one, where all of my tests were conducted, prior to my first visual inspection. That was early in the season and would have an influence in the amounts of nutrients the plant was able to take up. There was a direct correlation between root damage, chlorosis and yield. Vines which had root damage also had lower yields. That can be seen in Table 4.

How did you quantitate root damage?

TABLE 4: Average Yields of Vines-With and Without Root Damage

Variety	With (in pounds)	Without (in pounds)	Decrease (%)
Black Spanish	13.8	17.9	22.9
Champanell	5.1	5.9	13.6
Chenin Blanc	5.4[1]	9.1[2]	40.7
Lake Emerald[3]			
Ruby Cabernet	2.7	2.8	3.6

[1]Moderate to Severe Damage
[2]Mild Damage
[3]Lake Emerald did not produce

Black Spanish vines without root damage produced on the average of 17.9 pounds per vines as compared to 13.8 pounds produced on the vines with root damage. Champanell vines without evident damage produced 5.9 pounds per vine as opposeds to 5.1 pounds produced on vines with root damage. All the Chenin Blanc vines that were tested showed some damage so this group was seperated by the degree of damage which they incurred. Vines with moderate to severe damage produced 5.4 pounds per vine, while vines with mild damage produced 9.1 pounds. Ruby Cabernet showed insignifigant differences with 2.7 pounds per vine on damaged vines vs. 2.8 pounds on appearently undamaged vines. Ruby Cabernet was a very shy producer and is notorious for exhibiting Fe chlorosis readily. Lake Emerald did not produce.

This experiment included two visual inspections which were subjective. Determining chlorosis was difficult. The time of day and angle of the sun all had a part in precieving color. In determining root damage, it must be noted that the inspection took place almost a year after the damage occured so it is possible that some damage could have been masked over time.

During the time of sampling the management at the vineyard was fragmented and there is a possibility that micronutrients were applied and not recorded. This would certainly account for the inconsistancy seen in the ion concentrations found in tissue analysis.

In conculsion this test indicates that the reduced yield and chlorosis were caused by damage to the roots by the new cultivation practices. I recommend care be taken to disturb the roots as little as possible during cultivation.

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APPENDIX

TABLE 1. Result of Harvest on Grapes at the Messina Hof Vineyard

row	vine		# bunches	total weight in pounds	brix			#of grapes per bunch	bunch wt. in grams
Chenin Blanc									
2	2	*1	33	12	17.	20.	18.6	122	131.3
2	3	ˆ1	6	1	19.6	17.2	18.5	46	52.1
2	4	ˆ2	11	3.8	22	20.9	21.3	45	88.2
2	5	*2	18	7	19.1	19.2	20.7	76	136.3
2	6	*2	27	9.2	19.0	21.2	20.2	153	230.5
2	7	ˆ2	26	8.4	19.2	21.2	24.2	73	120.2
2	8	*2	27	8.4	21.3	20.8	22.7	62	116.3
2	9	*2	22	7.	22.1	19.5	19.9	88	132
2	10	ˆ3	19	6.3	20.4	23.3	24	71	95
2	11	ˆ2	17	6	20.3	20.2	22.1	73	107.25
2	12	*2	28	9	23	22.4	23.1	46	81.2
2	13	*1	25	9.5	22.2	21.4	20.3	98	173.4
2	14	*1	31	11.25	20.3	22.2	20.9	117	206.47
2	15	*1	42	17.8	20	23.1	22.7	68	140.3
2	17	ˆ4	16	5.5	22.2	22.9	22.1	114	144
Black Spanish									
10	15	ˆ0	71	11.75	21.2	15	18.3	105	169.39
10	16	*2	123	25.13	19.4	15.7	20.1	131	138.32
10	19	ˆ0	50	7.25	22.3	22.3	23	71	70.16
10	21	*0	101	25.75	15.6	19.4	19.9	222	169.39
10	22	*1	101	25.5	22.1	25.8	24.5	71	152.35
10	23	ˆ1	63	17.5	19.5	16.2	17.8	142	151.35
10	24	*1	109	27.25	12.2	13.4	19.1	180	155.36
10	27	ˆ1	78	17.75	16.9	18.2	18.7	159	106.25
10	31	ˆ0	85	16	16.7	18.2	17.2	92	85.2
10	34	*0	71	15.25	19.8	21.4	21.9	66	82.2
11	19	ˆ0	65	9.25	20.7	20.0	16.7	83	90.2
11	20	*1	98	32.25	18.3	20.2	19.1	111	132.31
11	21	ˆ0	102	18.75	16.6	13.3	15.2	111	100.24
11	25	ˆ0	10	3.88	21.	22.2	23.	94	101.24
11	26	*1	71	16.25	19.6	21.4	19.8	106	170.39
11	27	*0	76	16.25	22.7	21.6	22.2	126	104.27
11	29	*0	63	18	21.4	20.1	20.6	108	104.27
11	30	ˆ1	83	12.12	20.1	19.8	20.7	159	156.31
11	32	ˆ1	28	3	18.	15.2	17.3	77	75.18

row	vine		# bunches	total weight in pounds	brix			#of grapes per bunch	bunch wt. in grams
Champanell									
12	20	*0	59	6.13	14.1	12.6	14.3	21	68.17
12	21	^1	50	4.75	17.3	16.1	10.4	18	56.14
12	22	*0	67	4.88	15.8	15.2	14.7	12	43.11
12	23	^1	65	5	15.1	14.9	16.2	17	55.14
12	28	^1	62	4.75	15.2	15.3	16.0	19	70.17
12	29	*0	85	6.75	15.1	15.6	16.2	15	46.12
12	33	^3	81	6	15.2	15.3	15.0	15	48.12
Ruby Cabernet									
2	19	*3	88	6	19.5	19.4	20.3	38	60.15
2	21	*1	53	5.75	22	23.5	22.4	60	107.25
2	22	*1	44	2.38	18.2	20.3	21.9	43	50.13
2	23	^1	41	3.25	20.2	14.7	18.8	75	100.24
2	24	^1	43	2.5	24.3	26.9	22.5	14	24.07
2	25	^2	29	2.75	22.3	22	22.8	50	61.15
2	26	*1	73	5	22.2	21.4	21.6	58	94.23
2	27	^3	64	3.75	20.1	22.5	21.3	66	101.24
3	13	*4	91	5.25	15.6	21.2	18.7	70	84.2
3	17	^3	36	1	18.9	16.2	17.3	35	32.09
3	19	*3	51	2.13	19.4	20.8	21.2	39	58.10
3	20	*3	46	1.25	16	18.2	19.1	18	22.06
3	24	^3	41	1	20.1	20.3	17.3	19	20.06
3	25	*0	66	3.25	19.1	18.5	17.2	41	43.11
3	28	^0	20	.75	19.0	20.1	15.8	29	31.03
3	29	*0	46	2.75	21.7	21.4	21.3	89	74.18
3	31	*3	37	1	16.2	21.5	18.3	28	21.07

Lake Emerald did not produce

12	1	*0
12	2	*1

* Nonchlorotic
^ Chlorotic
0-4 Root Damage Ratings (0 being none)

TABLE 2: Petiole Analysis. Elements Listed in Parts Per Million.

Define codes

	B	Cu	Fe	Mn	Mo	Zn
Chenin Blanc						
R-2-V-2	*	25.310	177.766	176.418	173.722	173.273
R-2-V-3	*	16.797	147.266	145.898	268.750	144.922
R-2-V-4	*	12.433	156.531	205.962	158.628	150.689
R-2-V-5	*	15.047	126.182	232.588	175.838	154.987
R-2-V-6	*	11.386	102.327	223.981	97.383	140.232
R-2-V-7	*	10.954	154.262	273.860	124.400	144.208
R-2-V-8	*	13.374	124.875	293.328	223.152	192.346
R-2-V-9	*	10.026	99.212	205.607	175.828	161.462
R-2-V-10	*	10.946	90.114	130.448	52.779	129.998
R-2-V-11	*	18.135	228.118	227.068	89.628	137.440
R-2-V-12	*	7.196	125.325	135.519	152.159	98.940
R-2-V-13	*	8.698	125.375	135.573	172.466	98.980
R-2-V-14	*	8.998	98.080	218.806	103.629	153.119
R-2-V-15	*	11.988	278.571	219.381	213.686	167.532
R-2-V-17	*	9.304	287.215	269.508	52.521	78.481
Black Spanish						
R-10-V-15	*	12.005	118.698	122.749	63.325	64.226
R-10-V-16	*	13.050	96.750	195.900	51.600	55.200
R-10-V-19	*	8.545	113.32	110.933	64.012	55.767
R-10-V-21	*	9.306	98.459	149.640	39.324	48.479
R-10-V-22	457.441	8.702	149.280	199.540	68.564	59.112
R-10-V-23	274.390	6.597	68.223	77.819	64.624	43.633

R-10-V-24	246.253	8.393	124.101	144.035	57.554	53.807
R-10-V-27	249.201	13.487	137.712	87.812	38.212	52.597
R-10-V-31	145.505	8.242	124.376	76.424	90.060	48.551
R-10-V-34	193.568	8.390	203.905	106.972	76.558	51.688
R-11-V-19	147.303	6.893	102.947	127.522	84.066	41.209
R-11-V-20	124.650	7.641	132.141	151.169	54.535	64.872
R-11-V-21	88.394	9.588	172.893	181.432	48.542	88.843
R-11-V-25	76.919	26.989	270.192	623.001	113.804	165.384
R-11-V-26	70.715	15.431	219.487	470.435	201.209	129.744
R-11-V-27	76.708	18.578	257.391	714.043	159.559	167.499
R-11-V-29	28.373	8.106	120.546	139.462	49.089	53.143
R-11-V-30	27.437	11.910	287.789	786.935	114.121	139.447
R-11-V-32	25.210	21.609	305.372	732.593	230.342	179.322
Champanell						
R-12-V-20	*	20.380	161.089	1096.903	176.523	155.095
R-12-V-21	*	12.005	169.268	884.304	106.843	130.252
R-12-V-22	*	15.303	209.442	957.191	168.364	135.627
R-12-V-23	*	13.636	191.508	817.732	110.140	127.223
R-12-V-28	*	13.944	238.405	796.182	147.241	132.547
R-12-V-29	*	21.303	234.035	606.618	316.076	162.117
R-12-V-33	*	14.297	298.570	440.327	109.663	111.489
Ruby Cabernet						
R-2-V-19	*	11.838	110.889	94.555	26.973	61.738
R-2-V-21	*	7.493	111.339	86.314	35.365	69.381
R-2-V-22	*	9.594	135.669	139.866	62.213	73.906
R-2-V-23	*	10.194	169.704	194.583	81.401	90.995

R-2-V-24	*	8.850	137.550	118.200	43.800	64.050
R-2-V-25	*	8.841	123.776	103.996	128.721	82.118
R-2-V-26	*	11.548	193.311	94.181	30.144	56.989
R-2-V-27	*	10.200	192.000	84.900	43.350	82.800
R-3-V-13	*	12.138	136.364	313.636	60.090	82.717
R-3-V-17	*	7.802	125.425	124.255	49.810	40.958
R-3-V-19	*	13.195	165.234	154.588	64.024	82.617
R-3-V-20	*	11.243	143.464	124.275	70.907	111.233
R-3-V-24	*	11.559	132.556	96.527	51.041	81.215
R-3-V-25	*	10.198	146.071	141.272	46.941	83.683
R-3-V-28	*	11.402	137.277	90.618	97.670	115.823
R-3-V-29	*	9.752	156.631	132.326	49.210	104.121
R-3-V-31	*	16.206	169.868	138.205	75.330	127.101
Lake Emerald						
R-12-V-1	*	11.545	232.707	180.978	110.056	99.560
R-12-V-2	*	14.677	169.679	142.272	215.206	117.412

* Amount undetectable.