Vineyard Nutrition

Grape Camp

Michael Cook

Objectives

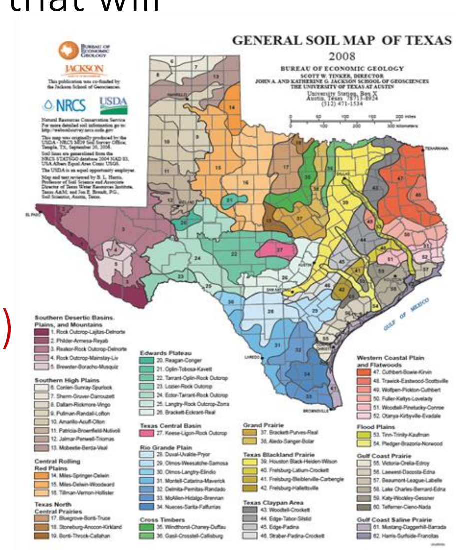
- What is a Vineyard Fertility Plan?
- Importance
- Principles of Vine Fertility
- Methods of Fertility Assessment
- Prevention & Correction of Fertility Issues

What is a VFP?

- A plan of action aimed at ensuring proper vine nutrition
- Should be done continually, but especially before you establish your vineyard
- “once the vines are in the fertility battle has begun”
- Yearly records are critical

Importance

- Have a prevention and correction plan that will ensure healthy vines with quality fruit
  - save time, effort, and money
- Prevent overuse of fertilizers
- Every vineyard site is different
  - need to know your vineyard (process)



Role of Nutrients

- Essential for proper vegetative and reproductive growth
  - nutrients deplete over time
- General deficiency issues include
  - retarded growth, yield reduction, poor fruit quality
  - foliar symptoms
  - increased disease occurrence and cold damage

- Over-application
  - excess vigor, poor fruit quality, increased disease, cold damage
  - toxicity and death

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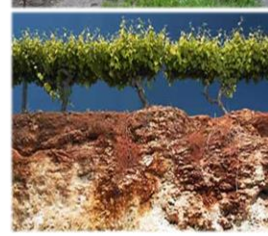
Principles of Vine Fertility

- all are essential
- motility and availability in soil and vine differ

Essential Nutrients for Normal Grapevine Growth and Development		
Obtained from Atmosphere and Water	**Macronutrients**	**Micronutrients**
Carbon (C)	Nitrogen (N)	Iron (Fe)
Hydrogen (H)	Phosphorous (P)	Manganese (Mn)
Oxygen (O)	Potassium (K)	Copper (Cu)
	Magnesium (Mg)	Zinc (Zn)
	Calcium (Ca)	Molybdenum (Mo)
	Sulfur (S)	Boron (B)
		Chlorine (Cl)

Factors Affecting Availability

1. Climatic & weather patterns
   - precipitation, flooding, waterlogging, leaching
2. Soil profile
   - texture, pH, salinity, and CEC
   - water holding capacity, drainage capability, erosion
3. Vineyard design & practices
   - site, cover crops, weeds, cropping level, scion/rootstock
   - “perennial crop dilemma”



Nutrients are removed from the vine

Tonnage per acre	Lbs. N	Lbs. P	Lbs. K	Lbs. Mg
2	6	1	10	0.5
4	12	2	20	1
6	18	3.5	30	1.2

Adapted from: The Lodi Winegrowers Workbook. 2008.

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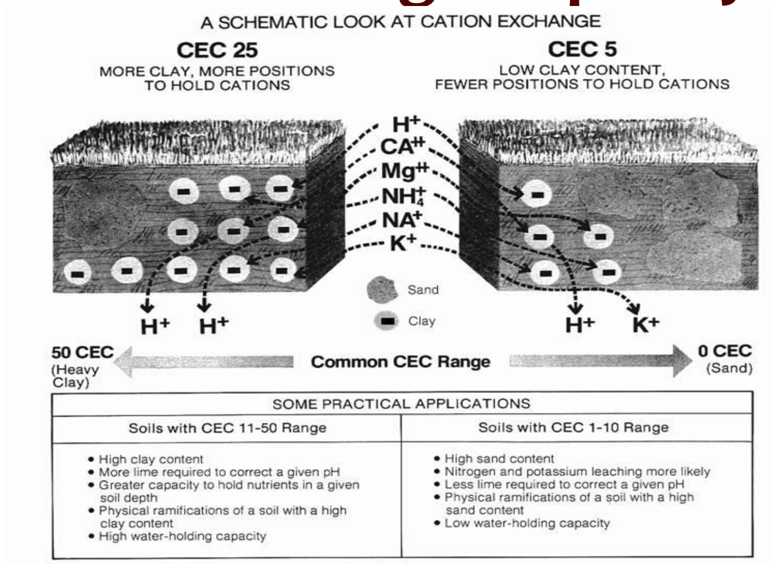
Soil – Cation Exchange Capacity



Courtesy of spectrumanalytic.com

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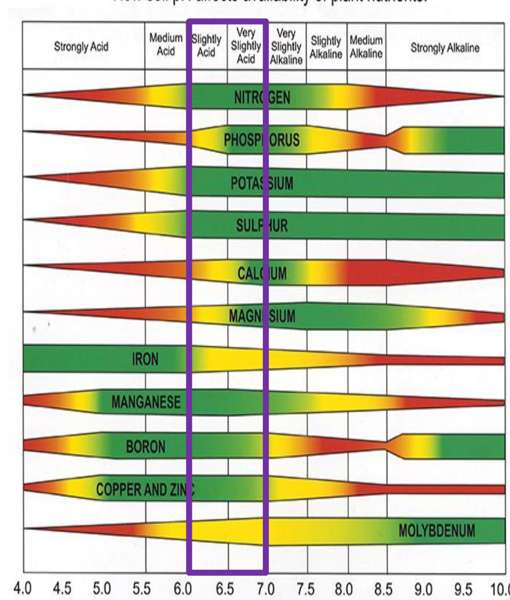
Soil pH

- Affects mineral solubility
  - may be found in soil but not available
- Acidic soils
  - often find Mo, P, Mg, Ca less available
  - while Al, Fe, and Mn more available
- Alkaline soils
  - often find Fe and Zn less available
- Amending Soil
  - extremely challenging and costly

How soil pH affects availability of plant nutrients.



Nutrient Mobility in Vine

Mobile	Moderately Mobile	Immobile
Nitrogen	Manganese	Iron
Phosphorous	Copper	Zinc
Potassium		Molybdenum
Magnesium		Boron
		Calcium

- primarily a function of solubility in phloem sap
- Mobile: capable of moving from older to newer tissue
- Immobile: incapable, often see symptoms in new tissue

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Methods of Measurement

Preventative vs. Corrective

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Soil Sampling

- Advantage
  - gives potential nutrient availability
  - may shed light on soil issues
  - "baseline" so look for trends
  - can be done pre-plant
  - timing not as critical
- Disadvantage
  - does not show soil/vine interaction

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Timing & Frequency

- **Pre-planting** – *ideal time to make soil corrections*
- Often collected during Fall or early Spring
- Do not take when ground is frozen
- Every 3-5 years thereafter, unless major amendment is made

Methodology

1. Choose several random locations (Z or W pattern) per block
2. Collect 10-20 “top-soil” samples by digging 8” deep per block
3. Collect “sub-soil” sample by digging 15-20” deep
4. Do not mix top and sub-samples
5. Dry and place in appropriate container
6. Mail off to Lab

Analysis

- Use the same lab or a lab that performs similar diagnostic tests for consistency

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Target Values

Target Values for Soil Samples	
Elemental Nutrient	**Soil (ppm)**
Nitrogen	--
Phosphorous	20-50
Potassium	75-100
Calcium	500-2000
Magnesium	100-250
Boron	0.3-2.0
Iron	20
Manganese	20
Copper	0.5
Zinc	2

Source: Wolf, T.K. 2008. Wine Grape Production Guide for Eastern North America

*Use petiole analysis to verify Nitrogen content because of many different nitrogen forms, which may change over time.

Nitrate is often the form tested on soil analysis

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Interpretation

- **Note:** lab test recommendations are often auto-generated and are generally geared towards annual crops rather than perennial
- **Fertilizer calculator:** http://soiltesting.tamu.edu/webpages/calculator.html

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Texas A&M System

Report generated for:

Soil Analysis Report
Soil, Water and Forage Testing Laboratory
Department of Soil and Crop Sciences
345 Heep Center, 2474 TAMU
College Station, TX 77843-2474
979-845-4816 (phone)
979-845-5958 (FAX)
Visit our website: http://soiltesting.tamu.ec

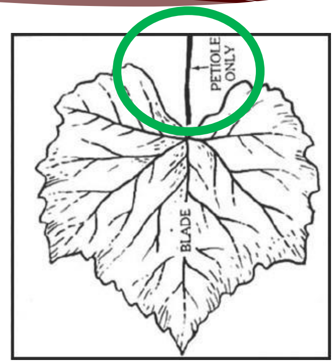
Sample received on: 8/16/2010
Printed on: 8/19/2010
Area Represented: not provided

Jefferson County
Laboratory Number: 311001
Customer Sample ID: Potting Mix
Crop Grown: FRUIT TREES

Analysis	Results	CL*	Units	ExLow VLow Low Mod High VHigh Excess.	Fertilizer Recommended
pH	6.1	(6)	-	Slightly Acid	
Conductivity	[illegible]	(-)	umho/cm	Slight	
Nitrate-N	26	(-)	ppm		0.2 lbs N/1000sqft
Phosphorus	92	(50)	ppm		0 lbs P2O5/1000sqft
Potassium	200	(175)	ppm		0 lbs K20/1000sqft
Calcium	1,743	(180)	ppm		0 lbs Ca/1000sqft
Magnesium	220	(50)	ppm		0 lbs Mg/1000sqft
Sulfur	259	(13)	ppm		0 lbs S/1000sqft
Sodium	174	(-)	ppm		
Iron	30.37	(4.25)	ppm		
Zinc	6.95	(0.27)	ppm		
Manganese	15.21	(1.00)	ppm		
Copper	4.29	(0.16)	ppm		
Boron					
Limestone Requirement					0.00 lbs/1000sqft

*CL=Critical level is the point which no additional nutrient (excluding nitrate-N, sodium and conductivity) is recommended.

Petiole Sampling



- Advantage
  - shows what the plant actually takes up
  - traditional "gold standard"
- Disadvantage
  - timing is more critical than soil sampling
  - more prep involved

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Timing & Frequency

1. **Bloom** – 50% -75% cap fall
   - micronutrient deficiencies can have season-long effect on fruit quality
2. **70 - 100 days post-bloom (veraison)**
   - major phenological changes occurring
3. **Diagnostic samples**
   - may be taken any time of year

- Should perform annually from year 1-4, then on a 2 year cycle thereafter

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Methodology

1. Select “data vines” for consistency
2. Collect from a single block and var. (ideal)
3. **Z or W** pattern throughout block
4. Test same time each year
5. Select from healthy leaves that receive ample sunlight
6. Morning is best

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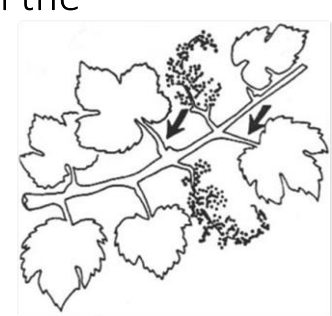
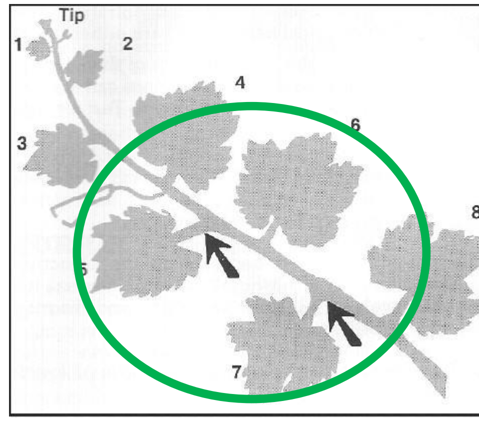
Methodology

1. **Bloom**
   - collect 60-100 petioles from leaves located opposite of the first or second flower cluster
   - no more than 2 petioles per vine, never on the same shoot (i.e. 30-50 data vines)
   - rinse petioles with distilled water/soap
   - place in brown bag (breathable)
   - dry at 80-90^{o}F for 24 hours



Methodology



1. Veraison
   - same as bloom but collect from youngest fully expanded leaves (5-7 leaves back from tip)
2. Diagnostic
   - collect 100 petioles from symptomatic leaves regardless of shoot position
   - same position on non-symptomatic or healthy vines
   - keep samples separated

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Petiole Target Values

Expressed as either a % or in ppm

Nutrient	Bloom	Veraison
N	1.2-2.5%	0.8-1.4%
P	0.15-0.4%	0.1-0.3%
K	1.5-3.0%	1.5-3.0%
Ca	1.2-3.0%	1.0-3.0%
Mg	0.5-0.75%	0.5-1.0%
Fe	30-100 ppm	30-100 ppm
Zn	30-100 ppm	30-100 ppm
Mn	25-1,000 ppm	100-1,000 ppm
B	25-100 ppm	30-100 ppm
Cu	6-25 ppm	6-25 ppm
Mo	0.5 ppm	0.5 ppm
Na	<1,000 ppm	< 1,000 ppm

Table adapted from Jim Kamas – Growing Grapes in Texas

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Interpretation

Actual Analysis

Element	Sample	Satisfactory Range	
+ Potassium	3.17	1.30 - 2.00%	Do not apply K unless soil test indicates a need. High K may increase risk of Mg deficiency. Resample next year.
Phosphorus	.202	0.10 - 0.30%	Omit phosphate from fertilizer program.
Calcium	1.63	1.20 - 2.00%	Test soil and apply lime as needed to maintain calcium supply.
Magnesium	.421	0.35 - 0.50%	Continue present magnesium program.
Manganese	51.4	50-1000 ppm	If manganese-containing fungicides or manganese sulfate sprays were applied this year, their use should be continued.
- Iron	24.0	30 - 100 ppm	Low iron levels frequently indicate impaired root activity related to physical damage, excessive or inadequate moisture, or pH effects. Consult Extension Specialist for specific recommendation.
Copper	12.7	5 - 15 ppm	No correction is suggested.
Boron	40.1	30 - 50 ppm	Continue present boron program.
+ Zinc	51.1	35 - 50 ppm	High levels may be from fungicide contamination of the sample and do not represent a problem.

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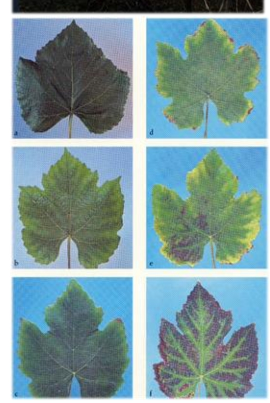
Visual Observations

- Corrective phase
- Look at vine
  - growth and vigor
  - crop size
  - vine balance
  - deficiency symptoms
  - toxicity symptoms
  - *note: visual symptoms may be result of plant stress, pest/disease pressure, or herbicide toxicity*



Prevention & Correction

Now that you have your test results or you are noticing nutrient deficiencies in the field, what do you do next?

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Macronutrients

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Nitrogen

- Typically the most deficient nutrient in the vineyard
- Very mobile in soil (Nitrate is anion) and plant
  - corrections are more successful
- Bloom petiole readings ok, but visual inspection is reliable
  - sufficient N when trellis is full and basal leaves are dark green
- Challenge
  - leaches heavily because its negatively charged and will not resist movement in the soil
  - are often over applied or at wrong time

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Nitrogen

- Deficiency symptoms
  - yellow chlorotic foliage
  - decreased shoot growth, short inter-nodal length, small foliage
  - symptoms often occur on the lower older leaves (**mobile nutrient**)
- Overuse & Toxicity symptoms
  - cane dieback from frost
  - leaf scorch with marginal browning (esp. young vines)

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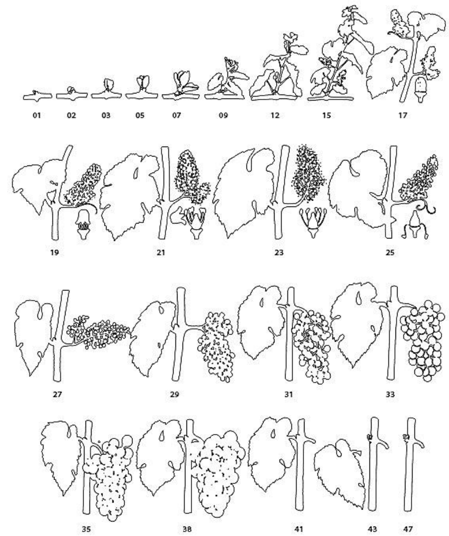
Nitrogen - Timing

- High N consumption during bud break to fruit-set
  - insufficient N leads to V/R competition
  - flower development and fruit-set can be diminished



1. After Spring Frost
   - traditional
   - applications halted in July
2. Post-Harvest
   - immediately post-harvest before frost
   - allows N to be stored until Spring for fast development
   - coincides with second flush of root growth
3. May also fertigate or apply foliar sprays for more immediate results

Nitrogen - Application

- Dry Application
  - leaching potential, important to split applications via band/ring under trellis
  - High vigor – no N
  - Medium vigor – 10-25 lbs. actual N/acre
  - Low vigor – 30-40 lbs. actual N/acre
- Fertigation
- Foliar Spray
  - may require multiple applications, toxicity an issue

Nitrogen -Sources

- Which source to use? Price, availability, quantity, salt index
- Read the label and abide by instructions

Chart Courtesy of Jim Kamas

Material	% N	Comments
Anhydrous Ammonia (NH_3)	82	Very volatile lq/gas
Urea	46	Volatile dry material
Ammonium Nitrate (NH_4NO_3)	34	Less volatile
Ammonium Sulfate $(NH_4)_2SO_4$	21	Volatile high pH soils
UAN 28-32	28-32	Volatile injected via drip

Phosphorous (P)

- Rarely an issue in Texas
- Deficiencies may be found in acidic soils
- Excess application can limit Zn and Fe

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Potassium (K)

- Demand is highest during fruit ripening
- Deficiency symptoms
  - starts with color loss at leaf edge (often early-mid summer)
  - marginal chlorosis, **reddening**, curling , and necrotic foliage
  - poor vine vigor, berry size, coloration, reduced soluble solids

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K deficiency with over-cropping

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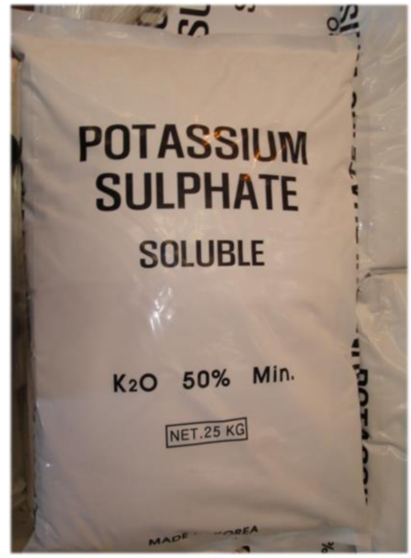
Potassium (K) – Timing & Application

- Timing
  - late Fall to early Spring
- Dry
  - furrow or banding over broadcast
- Fertigation
- Foliar Application
  - questionable efficacy



Micronutrients

Magnesium

- Deficiency symptoms
  - often found on high pH soil sites, heavy K fertilization, poor drainage
  - leads to reduced photosynthetic activity
  - marginal leaf “creamy” yellowing and/or reddening of basal leaves
  - noticeable especially during a heavy crop load and fruit ripening

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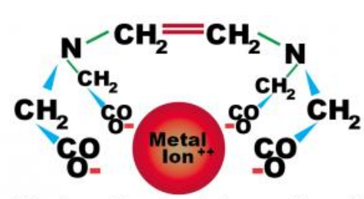
Magnesium – Application

- Timing
  - if 20% + of leaf area is chlorotic over large area
  - Fall
  - can use **K-Mag** (0-0-21) if need both K and Mg
- Dry
  - furrow or banding
- Foliar Application
  - often done in spring up to two times
- Fertigation

Chelation

- Some micronutrients are easily oxidized or precipitate in soil/solution
  - **Fe, Zn, Mn, Cu**
- Utilization is inefficient
- Natural chemical ligands combined with micronutrient = **chelate**
- Prevents oxidation and precipitation
- Often applied dry



Ethylenediaminetetraacetic acid (EDTA) chelates a metal ion

Zinc

- Deficiency symptoms
  - can occur in tandem with Iron deficiency
  - younger leaves often symptomatic first
  - small asymmetrical foliage along apex of shoots
  - leaf veins light in color
  - poor fruit-set "hens and chickens"

Zinc - Application

- Timing
  - 2-3 weeks prior to bloom
  - incorporate as a yearly maintenance spray program if persistent
- Foliar Application
  - most effective method
  - neutral Zn, or Zinc oxide
  - chelated Zn more expensive, no known advantage

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Iron

- Deficiency symptoms
  - mainly a problem on calcareous soils
  - affects apical leaves early in season resulting in general chlorosis
  - severe symptoms include ivory white or necrotic foliage, poor fruit-set
- Toxicity
  - rare
  - primarily pH related (drops creating abundance of available Fe)
  - dark green foliage, stunted growth of shoots & roots

Iron - Application

- Timing
  - 2 weeks before and after bloom for foliar spray
- Foliar Application
  - common but marginally effective
  - Iron sulfate and chelate
  - immobile so only benefits existing foliage
- Soil Application
  - must use chelated form of Iron
  - best option
  - **Acidification of irrigation water may make iron more available**

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Boron

- Deficiency symptoms
  - classic symptom is low bud break followed by slow shoot growth and short internodes
  - bushy stunted appearance
  - younger leaves first affected
  - foliage has mottled yellowing
  - clusters may set small scraggly BB size unseeded berries

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Boron – Application

- Toxicity
  - narrow threshold between deficiency and toxicity
  - old leaves have speckled appearance on outer edge
  - young leaves are cupped downwards
  - > 1ppm in water, > 100 ppm petiole

- Fertigation
  - must be very cautious due to toxicity
- Foliar Application
  - effective method, applied 2-3 weeks pre-bloom or even post-harvest

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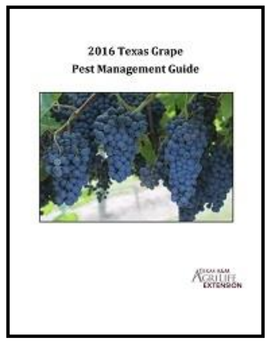
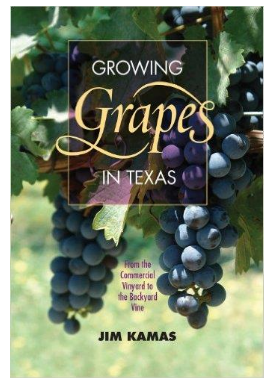
Further Resources

- Growing Grapes in Texas – Jim Kamas
- Texas Grape Pest Management Guide
- TWGGA





Any Questions?

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