WESTOVER
vineyard advising

Grapevine Nutrition
Approaches to Balancing NPK

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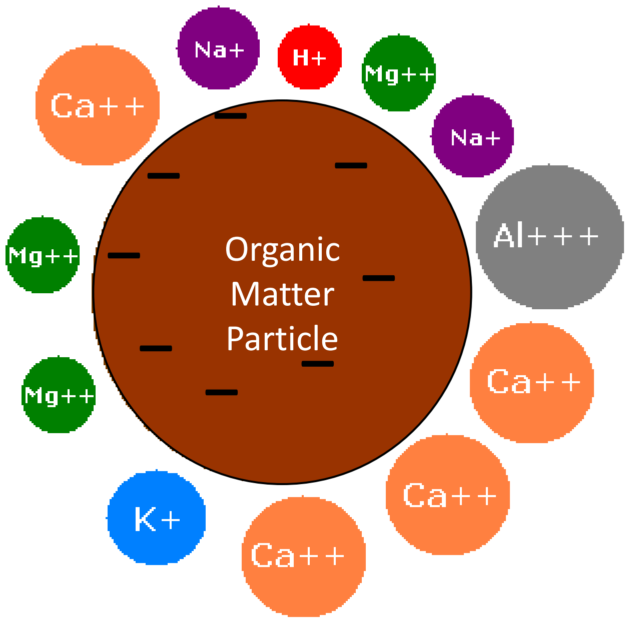
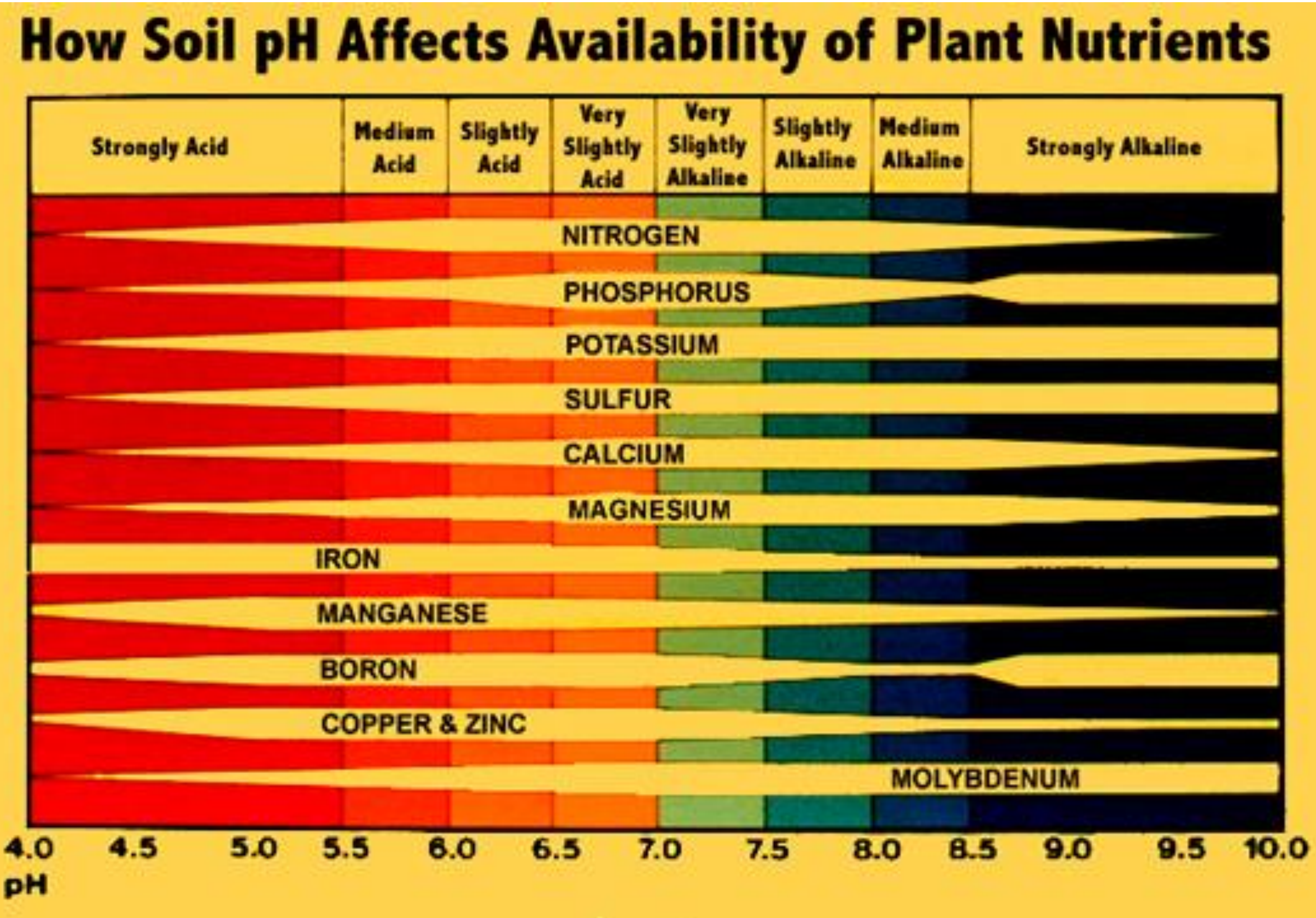
Know the commonly deficient nutrients in your site/region




How Soil pH Affects Availability of Plant Nutrients
Strongly Acid
Medium Acid
Slightly Acid
Very Slightly Acid
Very Slightly Alkaline
Slightly Alkaline
Medium Alkaline
Strongly Alkaline
NITROGEN
PHOSPHORUS
POTASSIUM
SULFUR
CALCIUM
MAGNESIUM
IRON
MANGANESE
BORON
COPPER & ZINC
MOLYBDENUM
4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
pH

Understand how nutrients are taken up by roots

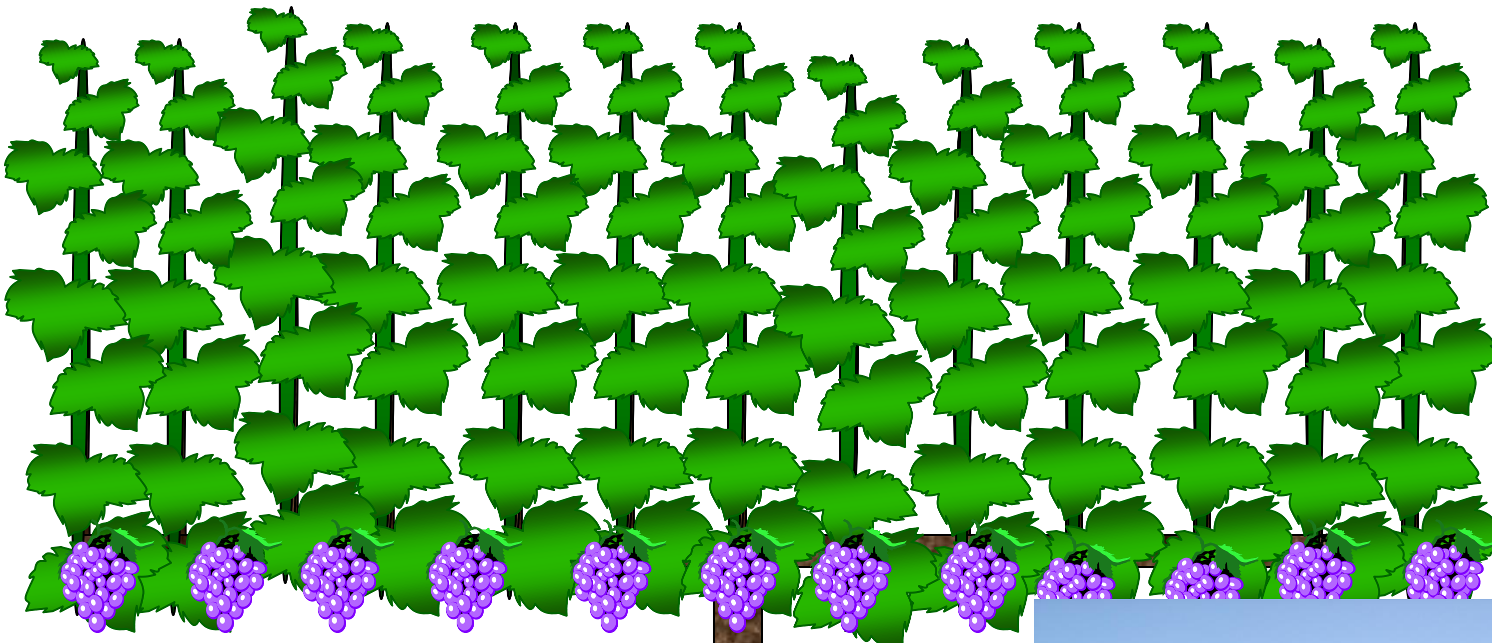
Nutrients that move with water solution (mass flow)
→ Rapid transpiration enhances nutrient uptake

→ NO_3-

Nutrients that are adsorbed by contact of growing root (diffusion)
→ Dominant form of uptake for most nutrients

→ K+
P(H_2PO_4-)

How do nutrients leave the vineyard?



Fruit (per ton)

N = 2-6
P = 0.4-0.8
K = 3-8
Mg = 0.1-0.4
Ca = 0.4-2

Pounds/Ton

Overcropping

- Other deficiencies intensified by heavy crop load (N, K, Mg)

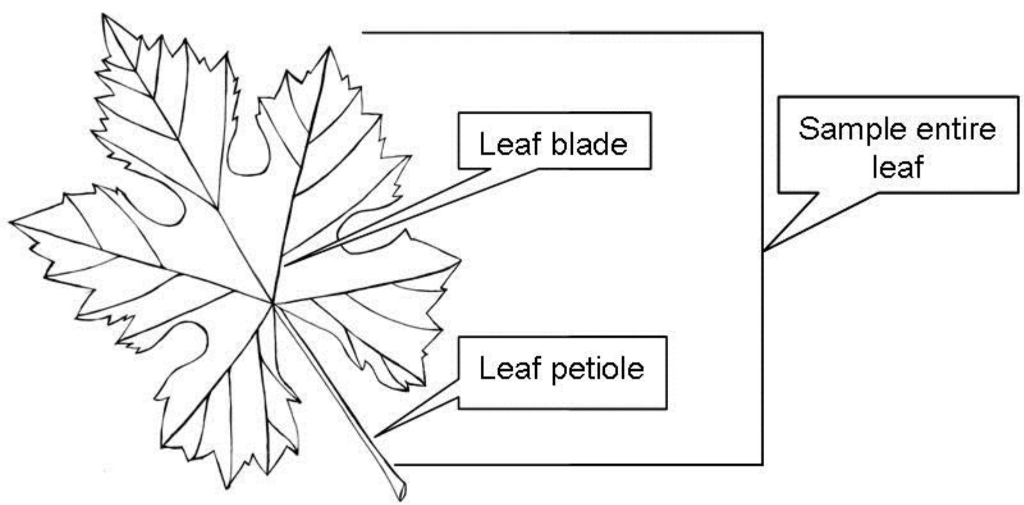
Sampling for Nutrient Management

Petiole or Leaf analysis tells us what the vine has taken up from the soil.

Soil analysis tells us what mineral nutrients are available in the soil for vines to access.

Blades and Whole Leaves

- Little difference between
- Storage organ
- Little sensitivity to conditions

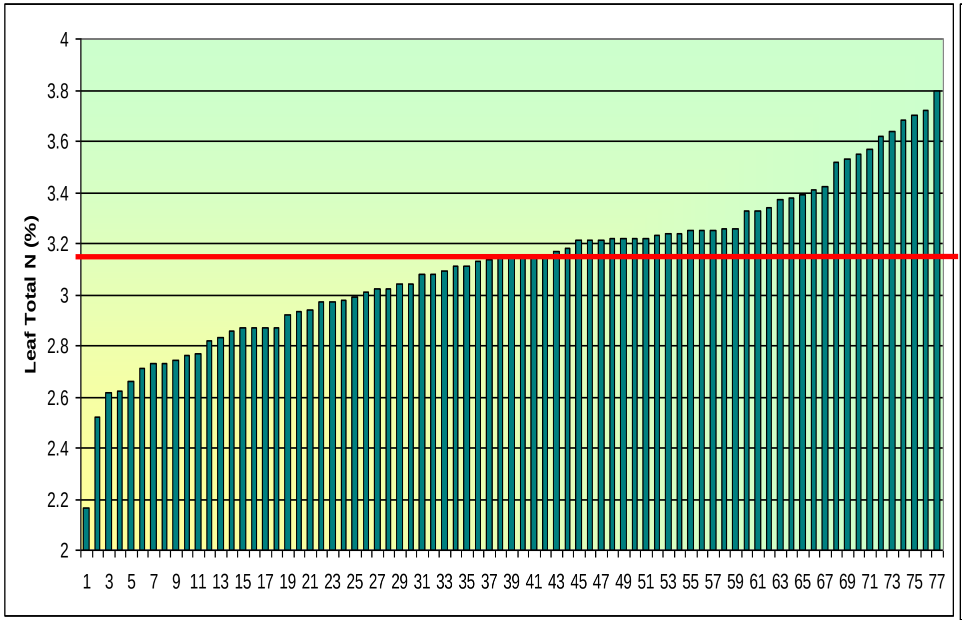


When and Where

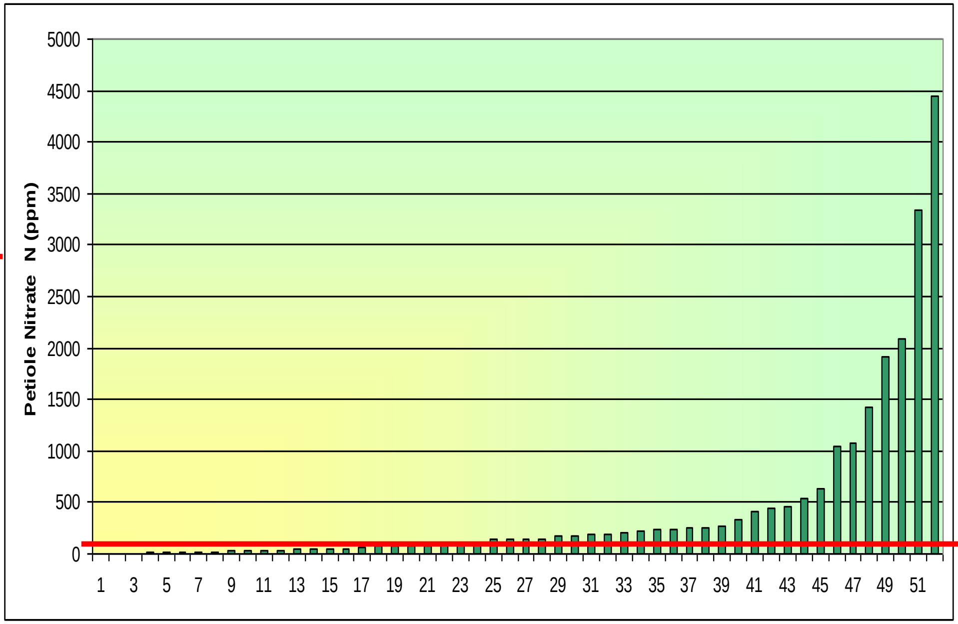
Figure 3. Grape vine shoot at bloom (left) and veraison (right) with appropriate leaf for sampling circled. (Please note that the three smallest leaves appear flat in this illustration, whereas on the actual shoot they would be curled in towards the shoot tip.)

Table 1. When, where, and how to extract grape leaves for nutrient analysis.

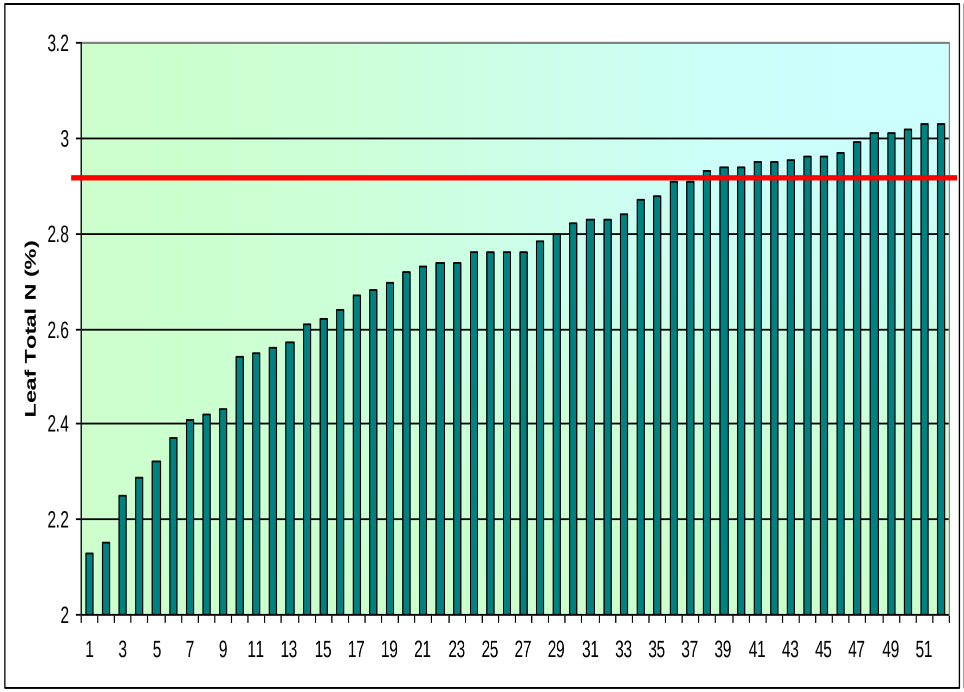
Sampling Time	Leaf Position (Figure 3)	Method
Bloom (30–60%)	Leaf opposite basal cluster of a primary shoot	• 50–100 leaves (target of 25 leaves per acre) • Random collection from both canopy and sides
Veraison (40–60%)	Fifth leaf (If the vineyard has been hedged, use untrimmed canes.)	



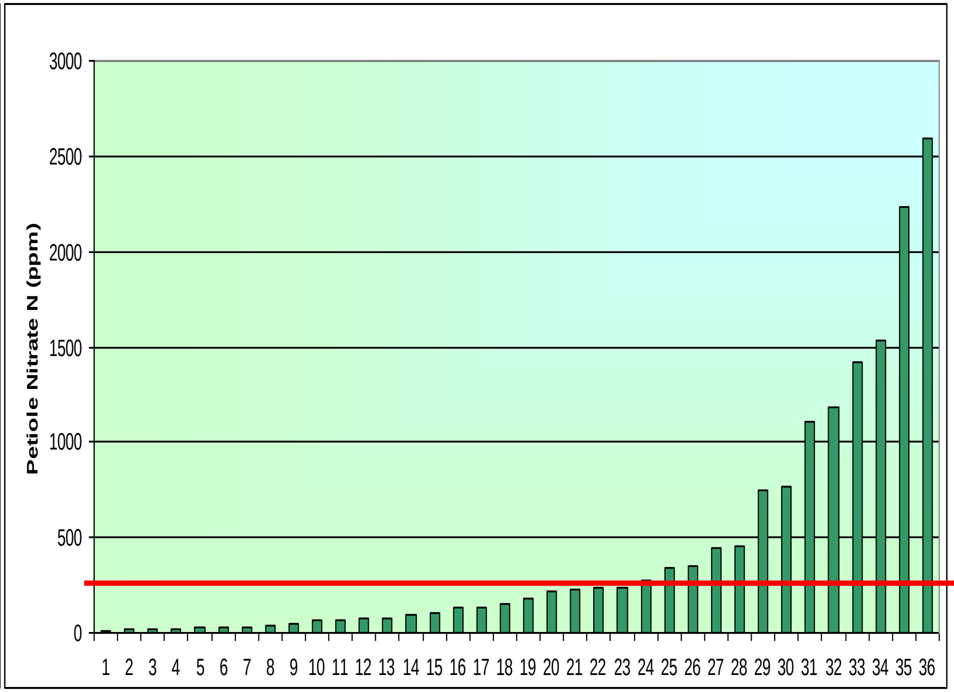
Leaf Total N (%)



Petiole Nitrate N (ppm)



Leaf Total N (%)



Petiole Nitrate N (ppm)

Petiole/Leaf Sampling at Bloom

Beginning of flowering or trace bloom
0 to 30% caps fallen

Bloom or full bloom
50-75% caps fallen

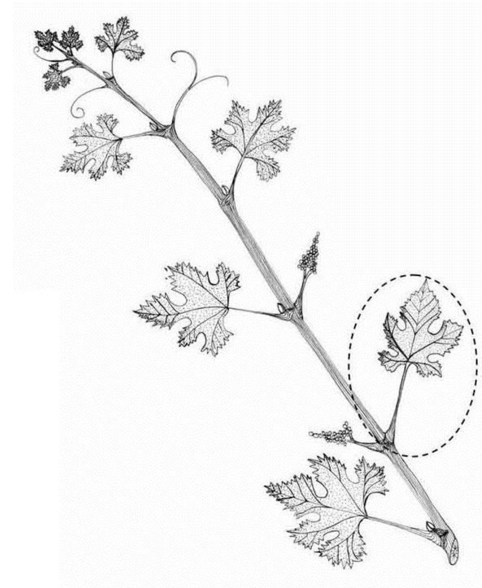
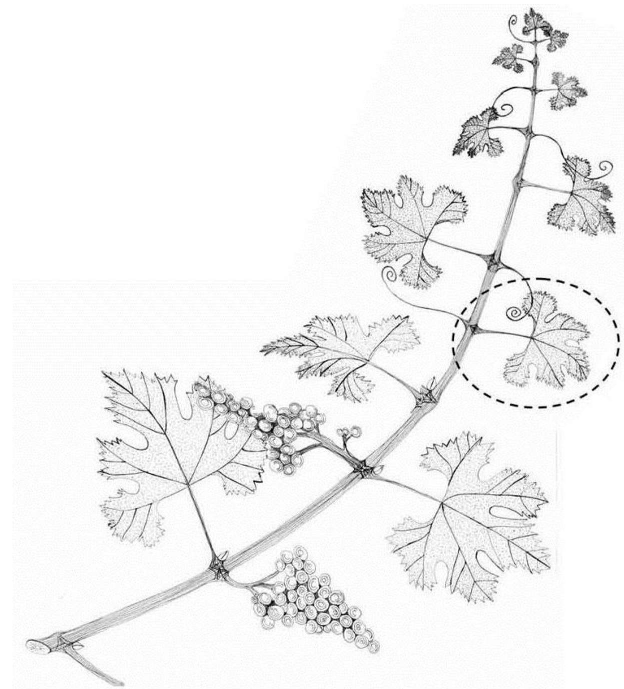


Photo: UC Davis

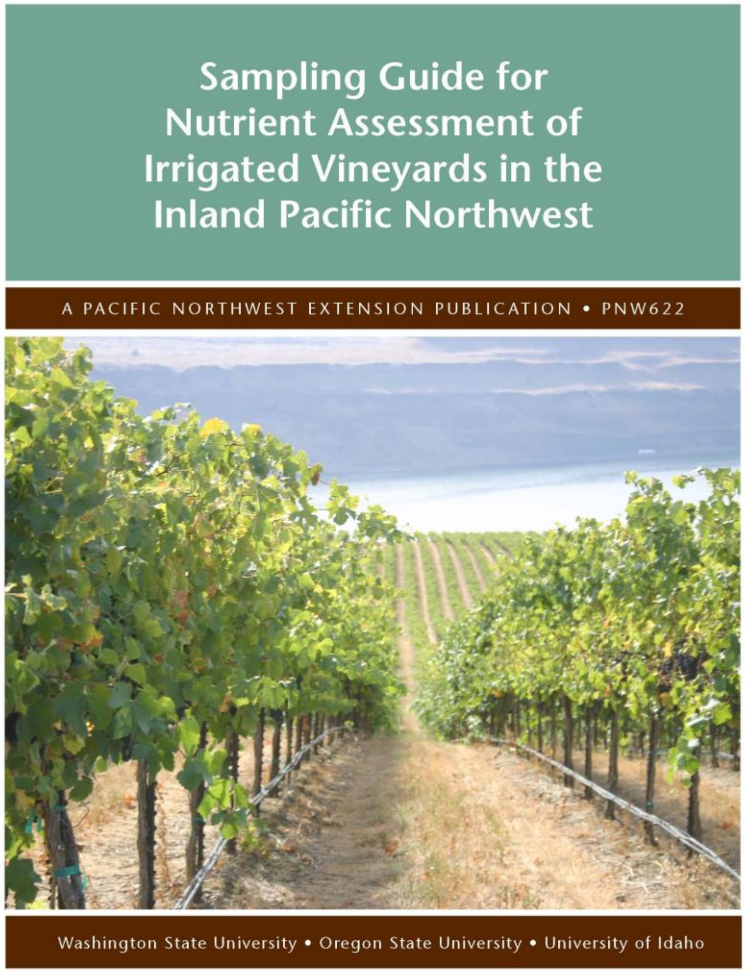
Petiole/Leaf Sampling at Veraison

35

Veraison 40-60%



PNW 622 Released January 2011



Sampling Guide for Nutrient Assessment of Irrigated Vineyards in the Inland Pacific Northwest

Joan R. Davenport, Professor and Soil Scientist,
Irrigated Agriculture Research and Extension Center, Washington State University, Prosser

Donald A. Horneck, Extension Agronomist and Associate Professor,
Hermiston Agricultural Research & Extension Center, Oregon State University, Hermiston

Acknowledgements

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https://pubs.wsu.edu/ItemDetail.aspx?ProductID=15405&SeriesCode=&CategoryID=&Keyword=622

Target Values

Table 2. Critical ranges for whole grape leaf samples used for tissue analysis.*

Nutrient**	Bloom	Veraison	
	Juice and Wine grapes	Juice grapes	Wine grapes
N (nitrogen %)	2.50–3.50	2.10–3.00	2.25–3.25
P (phosphorus %)	0.15–0.45	0.15–0.45	0.12–0.30
K (potassium %)	0.75–1.50	0.50–1.00	
Ca (calcium %)	1.00–3.00	1.00–3.00	
Mg (magnesium)	0.25–0.50	0.25–0.50	
B (boron ppm)	30–100	30–100	
Zn (zinc ppm)	25–100	15–50	
Fe (iron ppm)***	> 75	> 75	
Cu (copper ppm)	6–20	6–20	
Mn (manganese ppm)	30–100	30–100	

*Excessive concentration of plant nutrients, particularly micronutrients, can be toxic to vines. If tissue nutrient concentrations are significantly higher or lower than these values, contact an Extension specialist to help you review your results.

**Molybdenum (Mo) is rarely found to be deficient or excessive in grape, and nickel (Ni) or cobalt (Co) are not established as truly essential in grape.

***Iron (Fe) concentrations can exceed 75 ppm without being problematic for plants; no upper limit has been found for this nutrient in inland Pacific Northwest grapes.

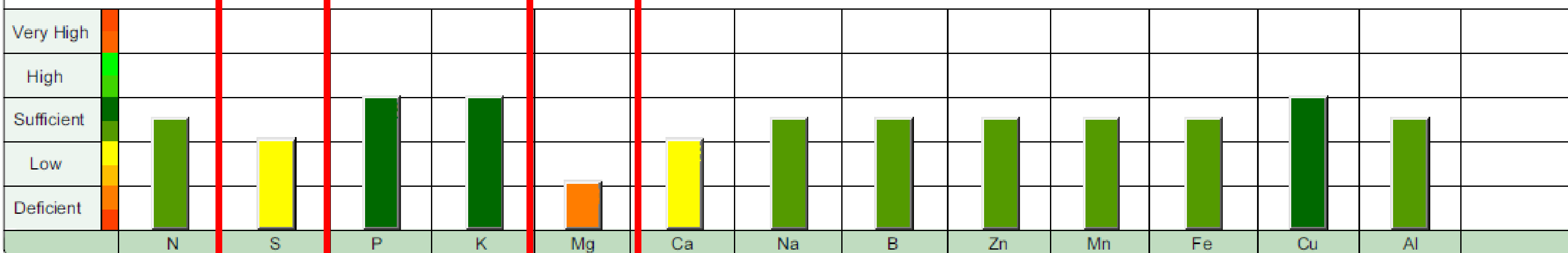
Interpretation

- **A nutrient is in the normal range**
  - Continue current practices
  - Consider vine vigor and crop load
  - Look at previous season (trend)
- **A nutrient is outside of the "normal" range:**
  - Modest Adjustment
  - Consider seasonal conditions
    - rainfall, solar radiation
  - Consider vine vigor and crop load

Example Laboratory Report

	Nitrogen %	Sulfur %	Phosphorus %	Potassium %	Magnesium %	Calcium %	Sodium %	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm
Analysis	1.00	0.12	0.29	2.26	0.16	0.99	0.08	29	54	372	57	15	25
Normal Range	0.80 1.51	0.13 0.36	0.15 0.35	1.20 2.50	0.35 1.26	1.00 2.50	0.00 0.20	25 71	30 80	100 1000	30 101	5 20	0 250

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Ca/B	Fe/Mn
Actual Ratio	8.3	0.4	2.4	53.7	14.1	60.8	341.4	0.2
Expected Ratio	4.7	0.6	1.0	45.5	2.3	33.6	364.6	0.1



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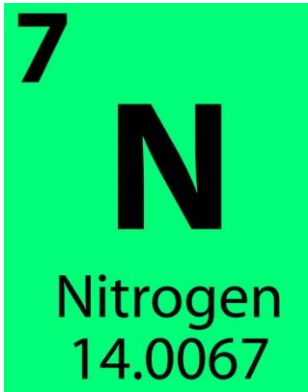
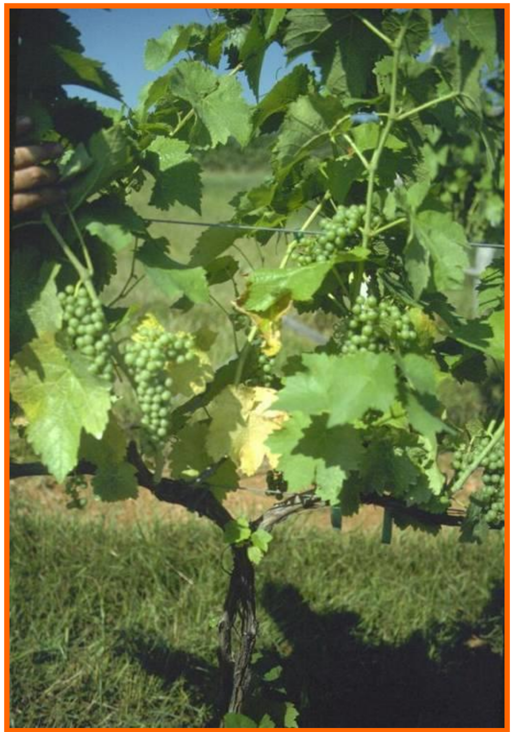
Nitrogen (N): Why it matters

Chemical component of:

- Nucleic acids → DNA → Genes
- Amino acids → Proteins → Enzymes
- Chlorophyll → Light interception
- Hormones → Communication
- Secondary metabolites → Color, flavor





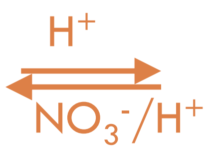
NITROGEN

N Deficit

- Shoot growth ⬂⬂
- Root growth ⬀
  → Drought susceptibility ⬂
- ABA ⬀, cytokinins ⬂
- Leaf photosynthesis ⬂
  → Chlorophyll ⬂
  → Sugar, starch ⬀
  → Anthocyanins ⬀
- Leaf senescence
  → Nutrient recycling to sinks (young leaves…)

Nitrogen uptake and processing

- N_2 in atmosphere (80%) useless for grapevines, not legumes
- Mostly nitrate (**NO_3^-**) in soil water
- Soil water $[NO_3^-]$ << Tissue $[NO_3^-]$
- Active uptake via H^+-ATP pump
  and H^+/NO_3^- cotransport → Soil pH ⬀



- Uptake requires **B** (for ATP pump)
  → Insufficient **B** may result in **N** (& **K**) deficiency
- Transport (xylem), storage (vacuole), or assimilation
  → Amino acids → Proteins
- Assimilation requires **Mo**, **Mg**, **Mn** or **Co** and sucrose
  → Expensive (requires sugar supplied by leaves)
  → Mo, Mg, Mn, Co deficiency may result in NO_3^- accumulation

Too much N? (Keller, 2005)

- High application rates of N may increase a vine's susceptibility to drought, because nitrogen favors shoot growth over root growth.

- Growth is the "pacemaker" for nutrient uptake by the vine (smaller vines require less nutrients).

Remobilization of N

- Dense shaded canopies – N remobilizes from shaded leaves to shoot tips or sun exposed leaves
- Remobilization also occurs in senescing leaves for storage in perennial vine parts = spring growth

Remobilization of N

- Majority of nutrient demand is from bud break to bloom when shoot growth is most rapid…. But most growers do not sample tissue until bloom!
- Late season sampling can tell the grower what is needed to meet demands from bud break to bloom in following season & application can be at veraison, post harvest, and again between bud break and bloom.

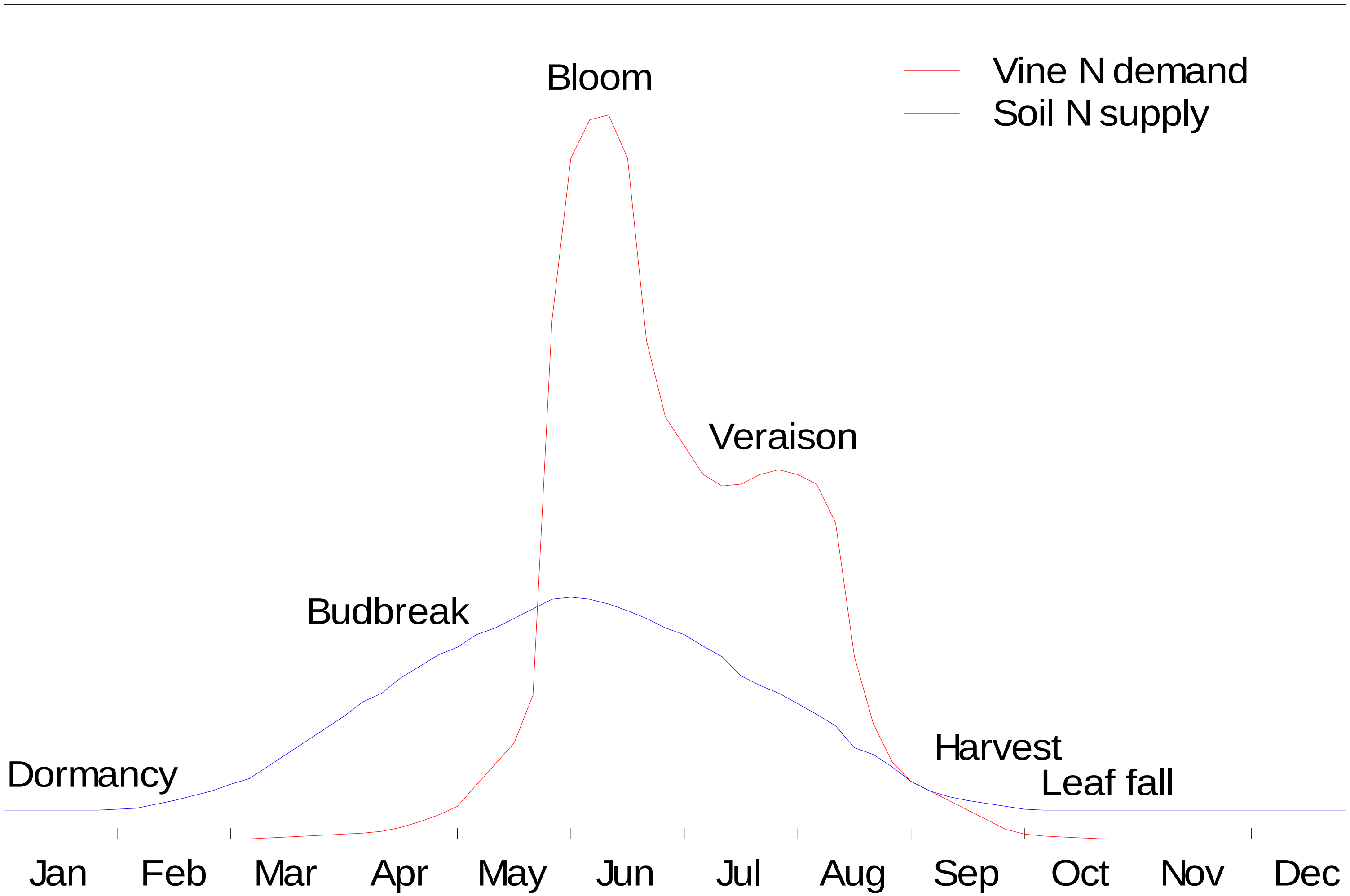
Common Fertilizers

N

Urea
Ammonium sulfate
Calcium nitrate
Diammonium phosphate
Monoammonium phosphate
10-10-10, 13-13-13, etc.

Timing N Fertilizer Application

- Storage reserves for budbreak (through bloom)
- Uptake mostly during rapid growth (>6-leaf stage)



Post Harvest Fertilization

- Ideally there are minimal deficiencies at harvest
- Mobile nutrients may become deficient if consumed by ripening fruit
- Nutrients removed from vineyard with fruit & canes
- Roots can take up nutrients between harvest and leaf drop… if the canopy is healthy

Spring Growth

- First growth driven by positive root pressure and remobilization of stored nutrients and starch

- After bud break, water/nutrient flow maintained by active transpiration of leaves

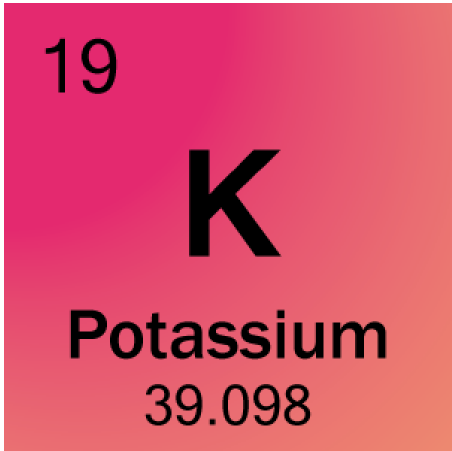
Irrigation effects N (Keller, 2005)

- Regulated deficit irrigation in combination with low to moderate N rates between bloom & veraison:
    - Reduced canopy size
    - Reduced berry size, yield
    - Accelerated ripening
    - Improves color
    - Reduces disease

- Too severe a deficit can limit assimilate supply and cause excessive fruit exposure

Potassium (K): Why it matters

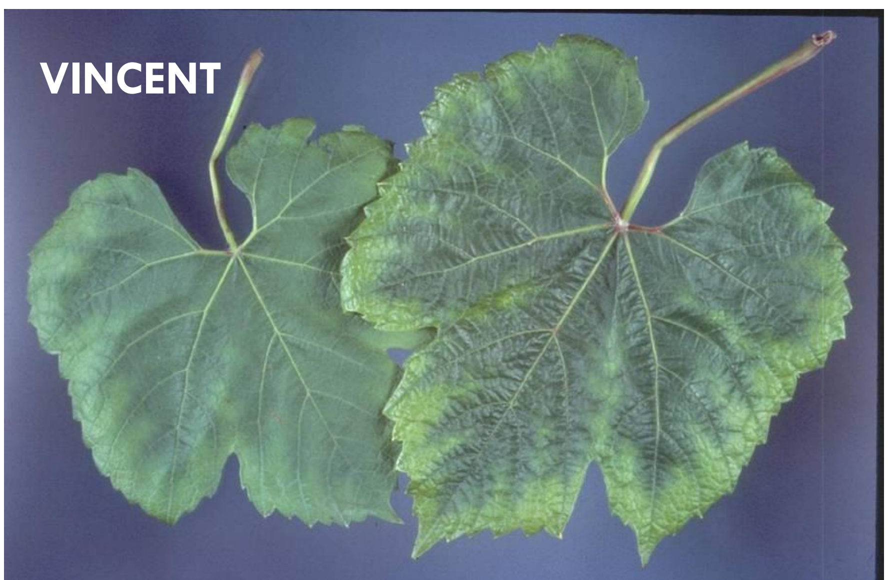
- Not assimilated (no organic compounds)
- Occurs as cation (K^+) in cells and apoplast
- Osmotic solute of cells
  - → Cell expansion
  - → Stomatal action (opening/closing)
- Neutralizes anion negative charges
- Counterbalances proton movement (K^+/H^+)
- Facilitates phloem loading of sucrose
  - → Sugar transport
- Reduces xylem hydraulic resistance
  - → Sap flow



TEMPRANILLO

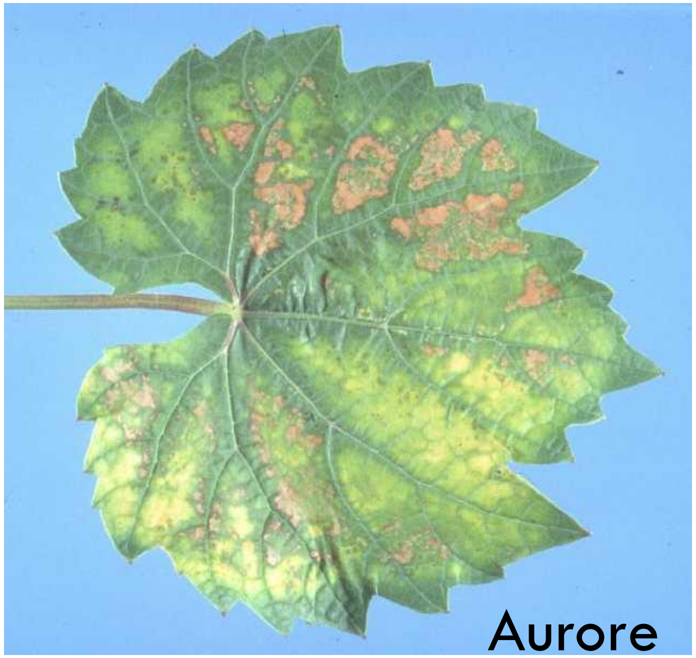
Chardonel, K = 0.71%

Potassium deficiency symptoms



EXAMPLES OF MAGNESIUM DEFICIENCY SYMPTOMS

Chardonnay: 0.19% Mg in petioles



- Symptoms typically on basal to mid-shoot leaves
- More common with low soil pH (< 5.5)
- Impact on fruit yield and quality not well quantified.

Potassium Deficiency

- Disturbed soils with subsoil at surface
- Sandy soils in high rainfall region
- Soils with high Ca or Mg

Photos from Tom Zabadal
Michigan State Univ.

Photo: Tony Wolf
Virginia Tech Univ.


K Deficit

- Common on high-pH soils
- Root growth ↘
- Shoot growth ↘
- Phloem loading ↘ (Sugar trapping)

  → Photosynthesis ↘

  → Fruit set ↘

  → Ripening ↘

  → Storage reserves ↘
- Berry shrinkage (not BS)
- Xylem sap flow ↘↘ → Drought stress
- Leaf senescence

  → Nutrient recycling to sinks

  (Heavy crop → More severe symptoms)
- Powdery mildew vulnerability ↗

Effects of Excess Potassium

- High fruit pH
- Reduced color of red grapes
- **Early leaf senescence moves K into fruit**

Common Fertilizers

K

Potassium chloride
Potassium sulfate
Potassium nitrate
K-mag, Sulpomag

Fertilization: Potassium (K)

Soil Application

- 1-3 lbs potassium sulfate per vine
- Late Fall to early Spring
- Furrow application – placed deep
- Response may take up to 2 years

Fertilization: Potassium (K)

Drip Application

Mild 0.5 to 1 lb potassium sulfate per vine

Severe 2 lb potassium sulfate per vine

Maintenance (through drip, K thiosulfate)

10 to 15 pounds of K per acre per week beginning after budbreak for 5-10 weeks

Fertilization: Potassium (K)

Foliar

- Many products, Questionable Efficacy
- 5 lb Potassium nitrate NOT EFFECTIVE

Phosphorous deficiency in Merlot

Riesling on low pH soil (R.M. Pool)

Merlot on low pH soil

Pinot noir. (R.M. Pool)

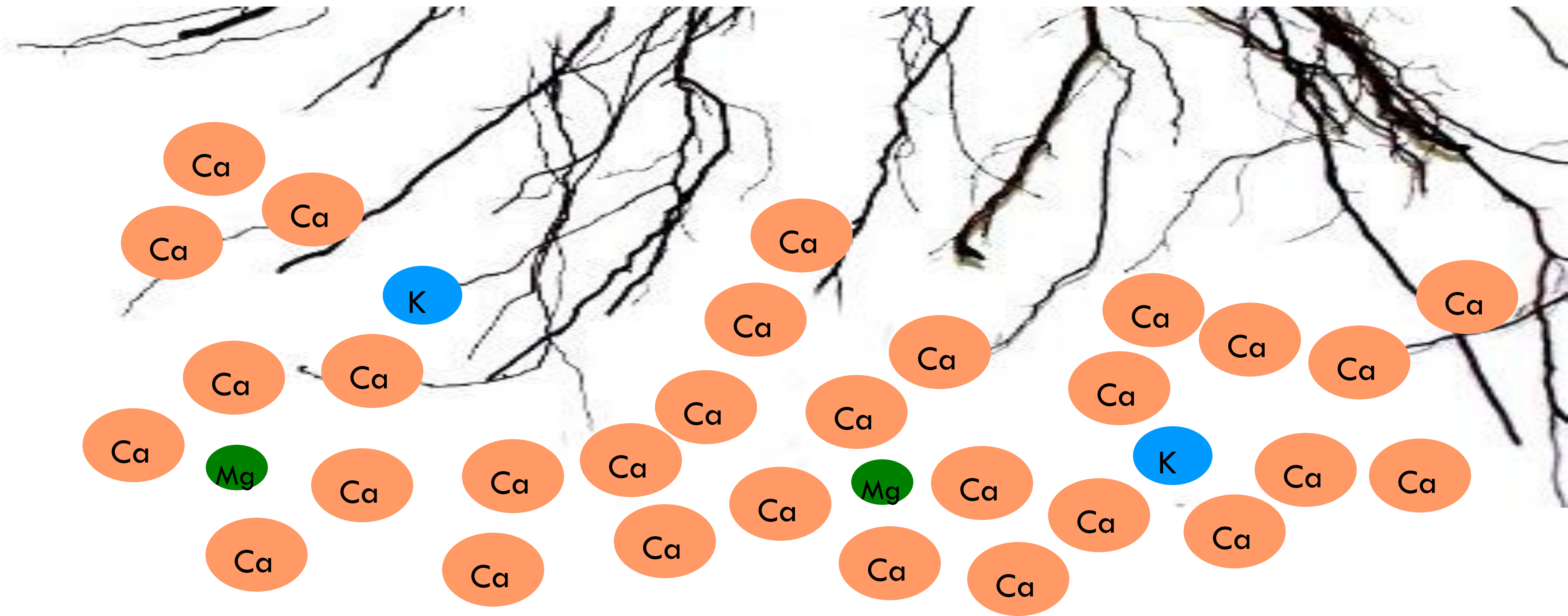
Common Fertilizers

P

Triple superphosphate
Diammonium phosphate
Monoammonium phosphate
Phosphoric acid
10-10-10, 13-13-13, etc.
(time with active root growth)

Nutrient ions may compete for uptake

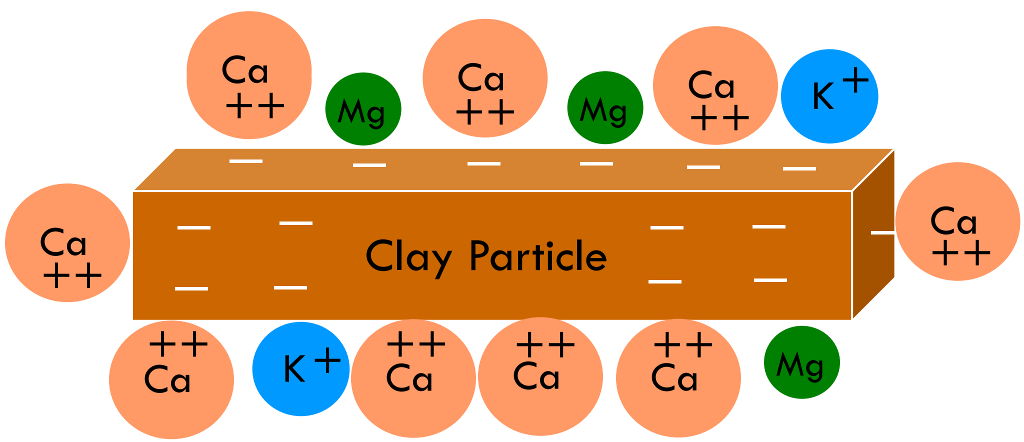
- High soil Na^+ (salinity) limits K^+ (and water) uptake
- High soil Cl^- (salinity) limits NO_3^- uptake
- High soil NH_4^+ (acid soils, < pH 5.5) limits K^+ and Mg^{2+} uptake
- High soil P limits Zn and Fe uptake due to complexation

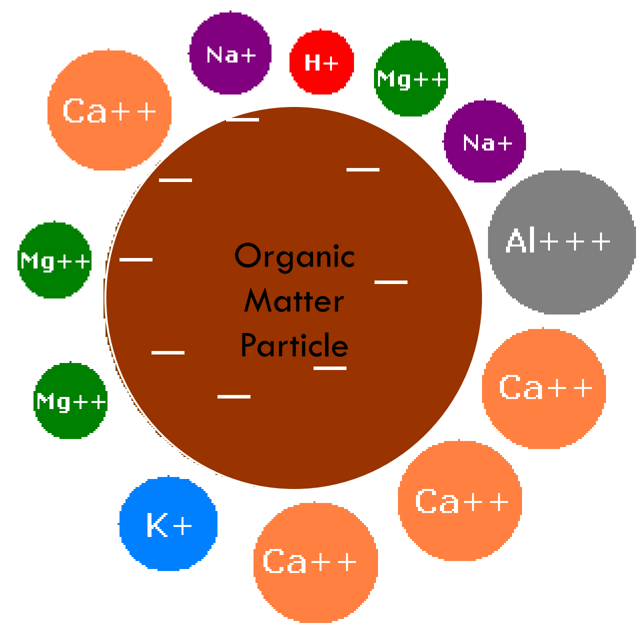


Nutrient ions may compete for uptake

- High soil K^+ limits Ca^{2+} and Mg^{2+} uptake (especially in young, grafted vines in acid soils)
- High soil Mg^{2+} limits K^+ (and P) uptake
- High soil pH (>7.5) favors Ca^{2+} and Mg^{2+} uptake and limits K^+ uptake

Watch fertilizer form (e.g. KCl?) under water deficit

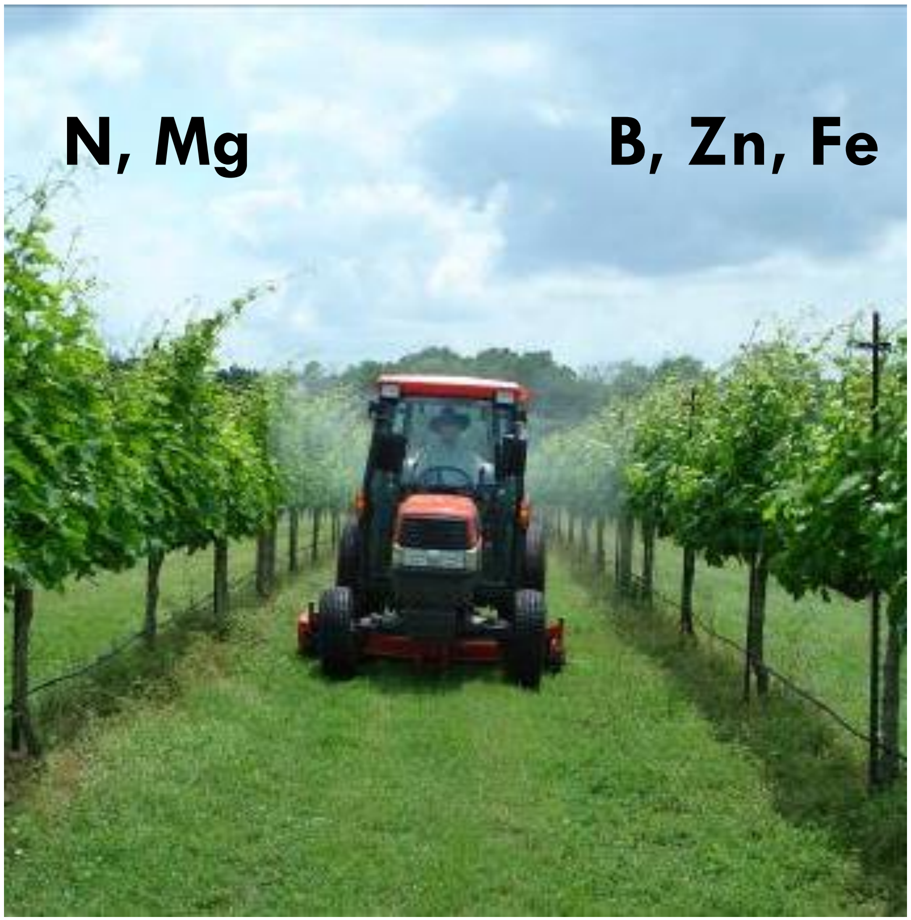


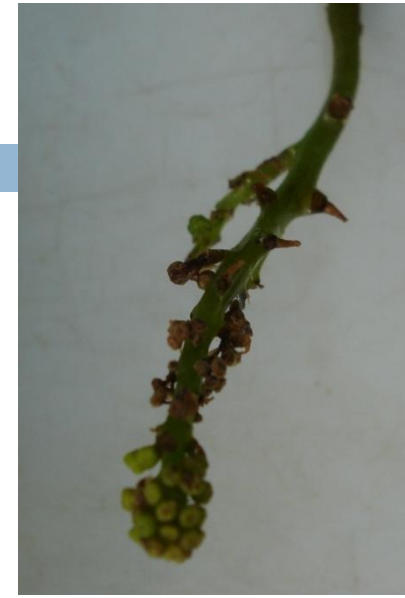


Application Methods & Timing

- Ground application
  - Broadcast or banded
- Foliar application
- Irrigation application "fertigation"

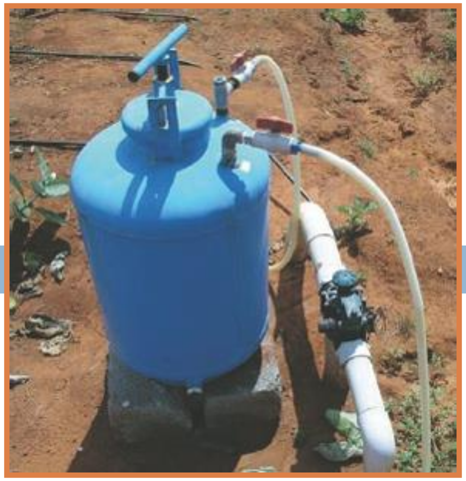
Foliar application





Keep foliar nutrient applications 10-14 days apart.

Fertigation



Examples of common incompatible fertilizer mixtures

Calcium + Phosphate or Sulfate
Ammonium Sulfate + Potassium Chloride
Magnesium sulfate + Di or Monoammonium Phosphate
Phosphoric acid + Sulfates of Iron, Zinc, Copper, Manganese
Phosphorus applications in high pH water may precipitate if water is high in salts.

Broadcasting vs. Banding of Fertilizers

Comparison of "organic" fertilizer source materials and comon synthetic fertilizers

Product	%N	%P	%K	%Ca	%Mg	Availability
Raw Vegetative Material						
Grape pomace	0.4		0.4	0.1	0.1	mod
Cottonseed meal	6	2.5	1.5	0.4	0.9	slow
Kelp	1.5	0.75	8	2	1	
Compost & Manures						
Compost (varies)	3	2	2	2	1	mod
Beef - feedlot	2	0.5	2	1	1	mod
Poultry	3.6	1.7	2	2	1	rapid
Animal by-products						
Bone meal	1 - 6	12	0			slow/rapid
Blood meal	12	1	1			rapid
Feather meal	12					mod
Fish meal	8	5	4			rapid
Minerals						
Calcium carbonate lime				32		pH dependent
Gypsum (calcium sulfate)				22		mod
Magnesium sulfate				2	10	rapid
Potassium sulfate			50			mod
Rock phosphate		3- 8 (avail)				slow
Dolomite limestone				25	10	pH dependent
Synthetic Fertilizers						
Calcium nitrate (CAN-17)	15			10		
12-26-26	12	26	26			
Ammonium phosphate	10	34				

Stockpiling of Grape Waste

Compost can contain weed seeds

Application Methods & Timing

Photo: Doug Beck

Application Methods & Timing

Photo: Doug Beck

Mulch spreader side dressing compost

Compost Rate Worksheet - Vineyard Application

Date:	
Vineyard Block:	
Compost Source:	
Compost Type:	

Method 1: Determine the rate of compost to apply based on desired available nitrogen in year one.

(green)	Fill in the green boxes based on the analysis results from the lab or suggested default.
(yellow)	Fill in the yellow boxes with your desired criteria.
(red)	Results for estimated nitrogen from compost and application/order rates appear in the red box.

Analysis Numbers from Lab	% wet	lb/yd^3	lb/ton	Estimated Nitrogen Available Year 1		Estimated Release lbs/Ton Compost	Desired Nitrogen Per Acre (lbs)	Compost Rate Tons/Acre	Total Acres	Total Compost Order (tons)	Total Compost Order (yd^3)
N	2.62	21.2	52.4	0.20	*	10.5	50	4.8	5	24	59
Wt/Vol lb/yd^3	810	→ Range is 800 to 1000 lbs									

Method 2: Determine the available nitrogen based on the rate of compost applied.

N lb/ton	Compost Rate Applied	Total lbs N Applied	Estimated Nitrogen Available Year 1		N Availability By Time of App. (From Table 1)	N Availability By App. Method (From Table 2)	Available Nitrogen Per Acre (lbs)
52.4	4.8	252	0.20	*	0.3	0.65	49.0

Table 1:

Nitrogen availability based on time of application before bud break.

1 Month Before	0.5
3 Months Before	0.4
6 Months Before	0.3

Table 2:

Nitrogen availability based on application method.

Worked into soil or rained in same day	0.85
Worked into soil or rained in next day	0.75
Left on surface for more than 2 days	0.65

To download an updated version of this compost rate calculator click here.

Compost Rate Worksheet

Date: 2/16/2012
Vineyard Block: Example
Compost Source: Comgro Soil Amendments
Compost Type: Grape Pomace
Source Contact: Johnny Massa

Compost Nutrients	% wet	lb/yd^3	lb/ton	Estimated Nutrient Available Year 1	Estimated Release lbs/Ton Compost	Desired Nutrient Per Acre (lbs.)	Compost Rate Tons/Acre	Total Acres	Total Compost Order (tons)	Total Compost Order (yd^3)
N	2.62	21.2	52.4	0.20	10.48	50	4.8	5	24	59
P	0.99	8.0	19.8	0.40	7.92	38				
K	3.13	25.4	62.6	0.60	37.56	179				
Ca	1.14	9.2	22.8			↑				
Mg	0.55	4.5	11.0							
S	0.20	1.6	4.0							
Na	0.11	0.9	2.2							
Al		0.0	0.0							
Fe		0.0	0.0							
Mn		0.0	0.0							
Cu		0.0	0.0							
B		0.0	0.0							
Zn		0.0	0.0							
Wt/Vol lb/yd^3	810	Range is 800 to 1000 lbs								
pH	7.2									

If you apply 5 tons of compost/acre, 50 pounds N/acre will be avialable in year one, as will 38 pounds/acre P and 179 pounds/acre K

Notes:
Compost rates based on (limited by) desired N rates
Actual N based on 20% release in year 1. 1st year release considered only.
P and K release estimated as 40% and 60% respectively.
PPM converted to % : 1% is equal to 10,000 ppm or 1 ppm is 0.0001%

Chardonel, K = 0.71%

NPK Fertility in Young Vines

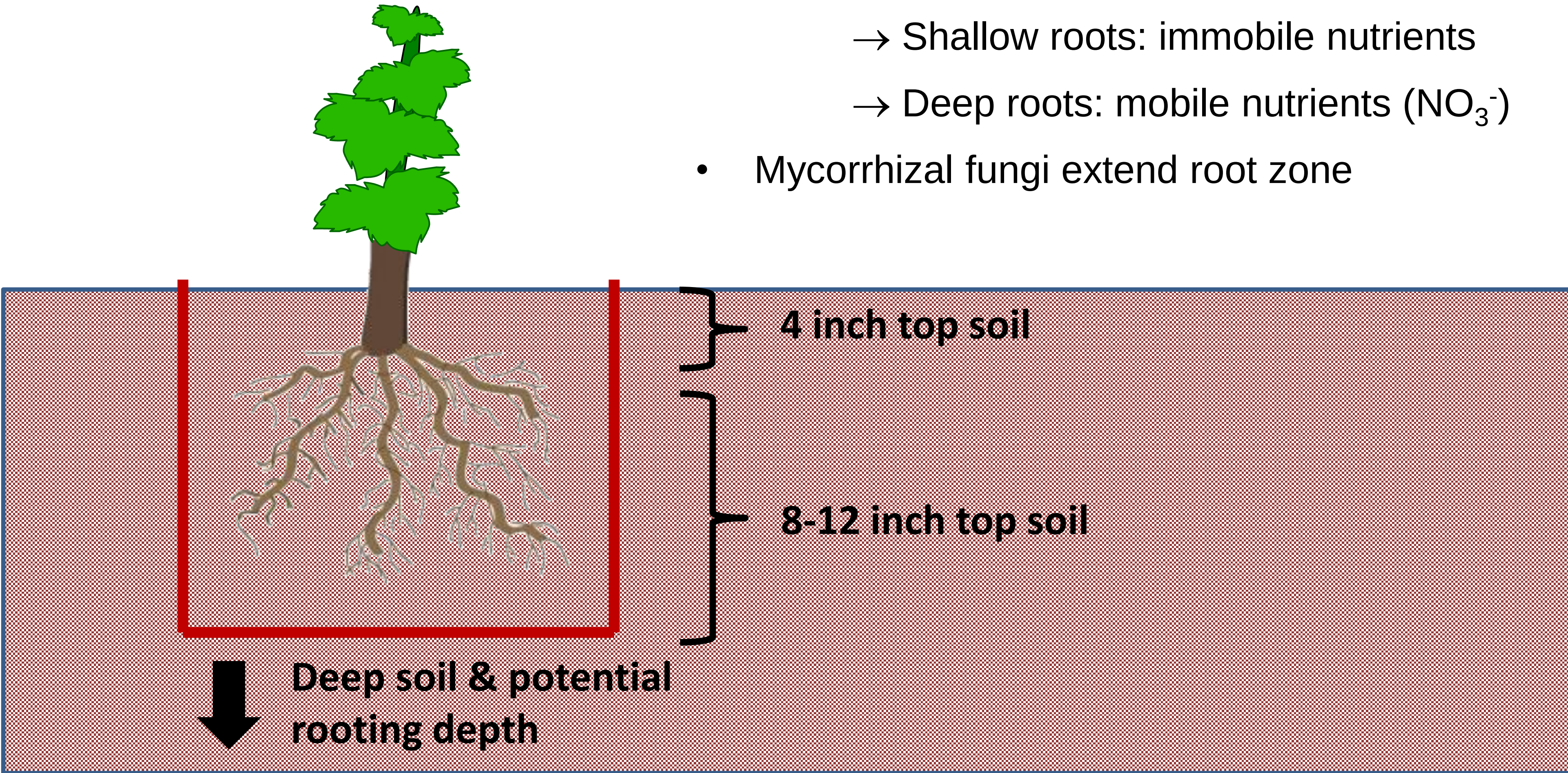
- Different nutrients in different locations

  (leaching: $NO_3^- >> K^+ >> H_2PO_4^-$)

  → Shallow roots: immobile nutrients

  → Deep roots: mobile nutrients (NO_3^-)

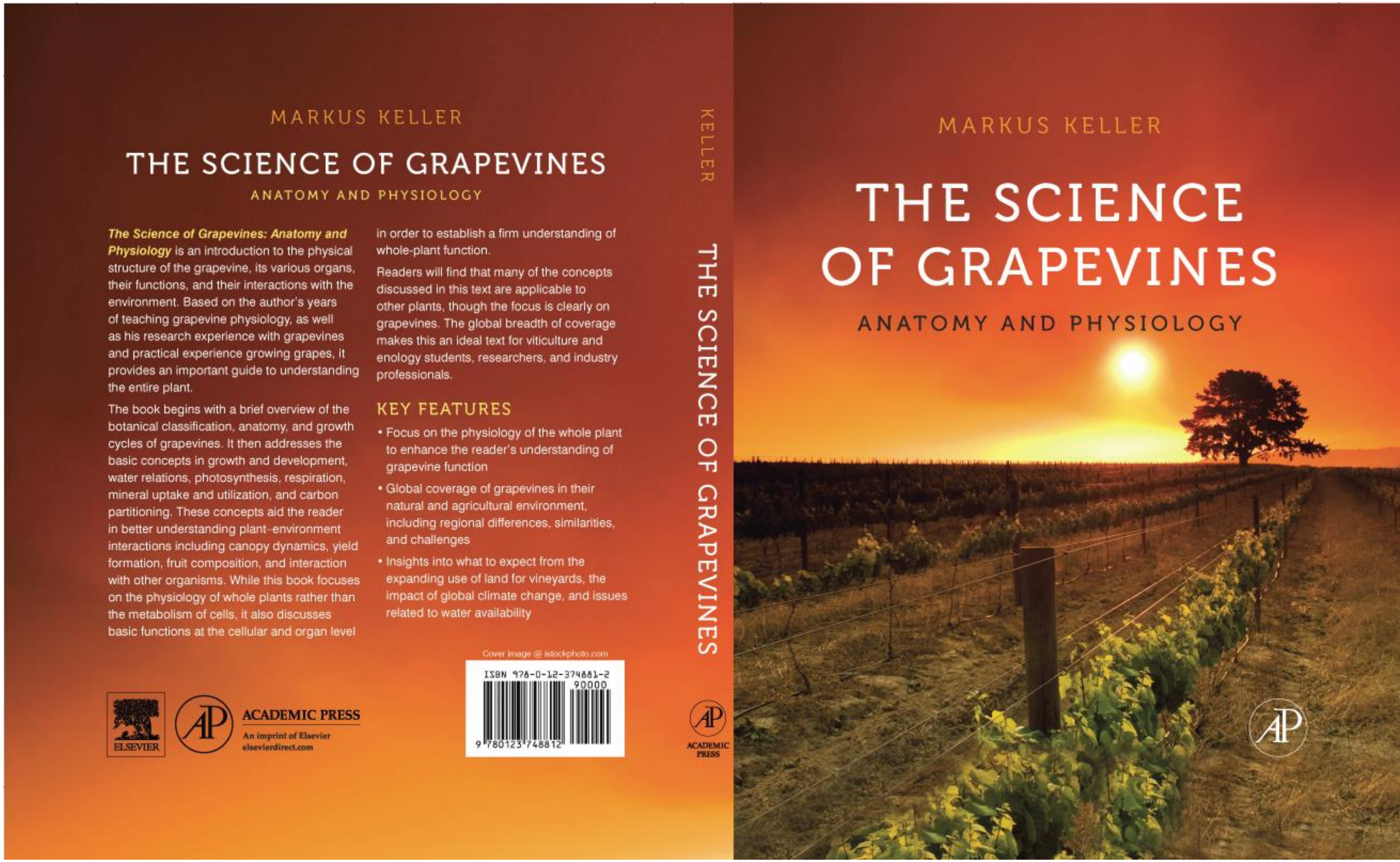
- Mycorrhizal fungi extend root zone



Advice

- **Before planting your vineyard:**
  - Add needed fertilizer and amendments before planting and incorporate to rooting depth (based on soil tests)
- **After your vineyard is planted:**
  - Add only the fertilizers that are needed, and at only the rates needed (based on plant tests and visual observation)
- **Add fertilizer at the time of optimal vine uptake**
  - Based on fertilizer and application method

Recommended Reading



www.amazon.com/Science-Grapevines-Anatomy-Physiology/dp/012374881X

www.VineyardAdvising.com

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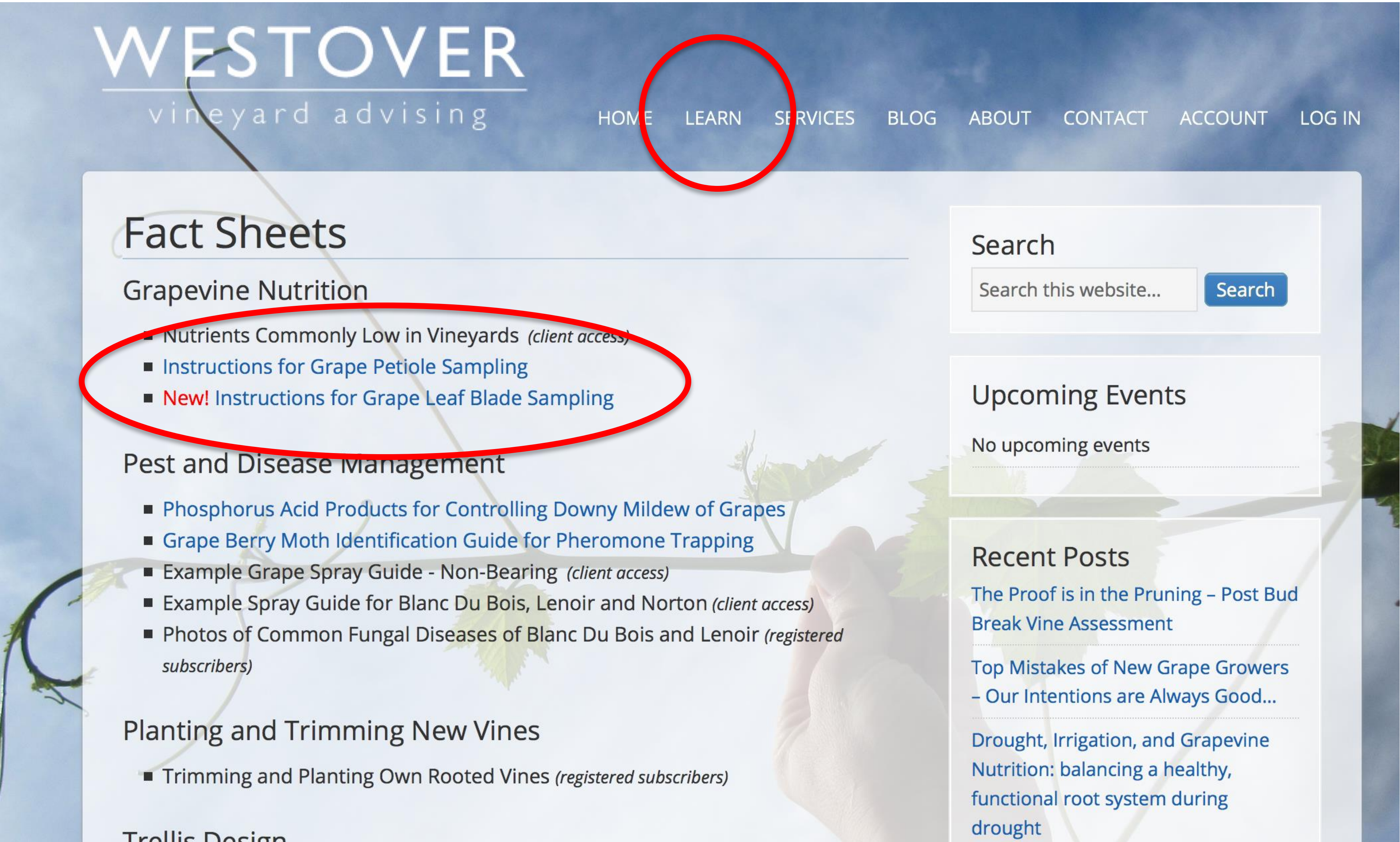

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