Grapevine nutrition: Beyond the basics

Georgia Wine Producers 2018 conference
24 January 2018

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Virginia Tech

Photo credit: RdV Vineyards

PRESENTATION OVERVIEW

- Pre-plant activities
- Post-planting
    - Immediate vine needs
    - Nutrient assessment in the established vineyard

- Nutrient "issues" that we are interested in
    - Lime requirements
    - Nitrogen
    - Potassium (excessive potassium is more common)
    - Other essential elements

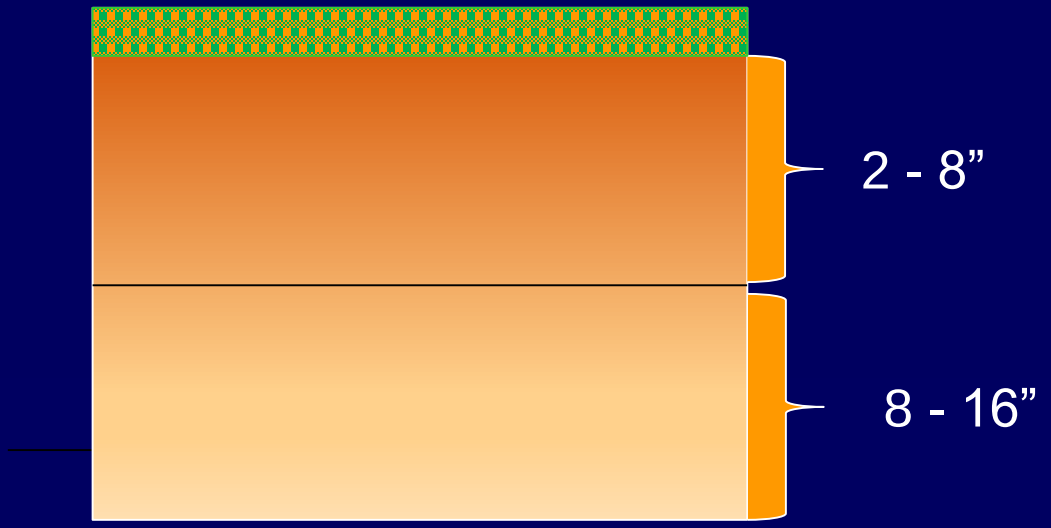
Pre-plant nutrient assessment:

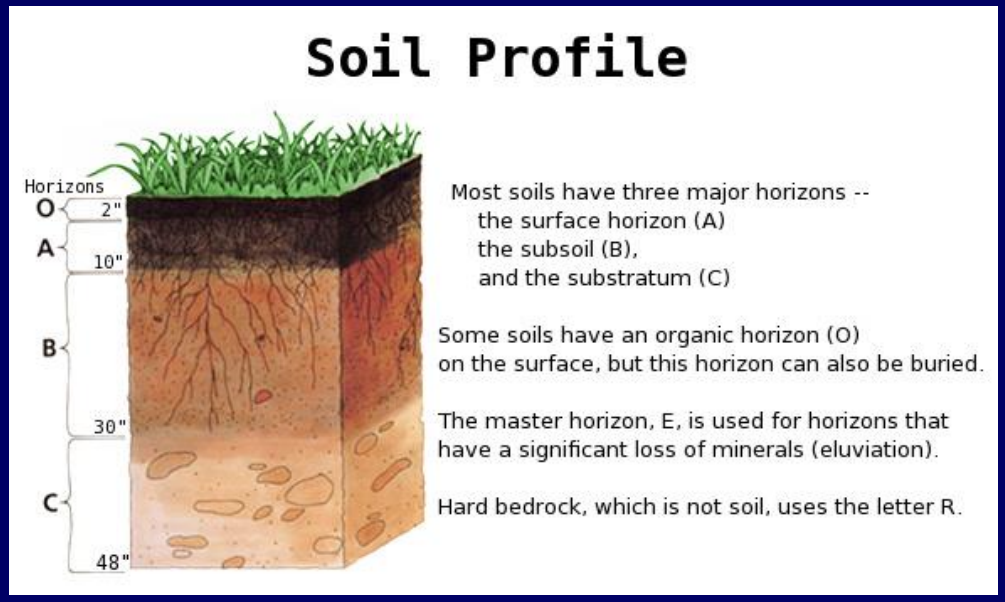
- Based on soil testing
- Sets the stage for sustained, optimal vine health, crop yields, and high crop quality
- Taking short-cuts at this point will hamper efforts to attain this long-term goal

Established vineyard nutrient assessment (VSP):

- Visual: (how do the vines look and perform with respect to yield, canopy/trellis fill, foliage color, and cane pruning weights (0.2 – 0.4 lbs/foot of canopy)
- Soil tests: Pre-plant and every 2-3 years thereafter.
- Plant tissue analysis: Routine vs. trouble-shooting.

Soil testing





Collect soil samples at two depths: e.g., 2-8 inches and 8 – 16 inches. The top 2 (or more) inches should be excluded.

Pre-plant activities

Soil testing - important both in pre-plant phase and in the established vineyard

Collect prime samples on a grid over intended planting area and collect 5-10 subsamples per prime sample.

EXAMPLES OF SOIL TEST RESULTS

SAMPLE HISTORY

Sample ID	Field ID	LAST CROP		LAST LIME APPLICATION		SOIL INFORMATION				
		Name	Yield	Months Prev.	Tons/Acre	SMU-1 %	SMU-2 %	SMU-3 %	Yield Estimate	Productivity Group
FT123				18+						

LAB TEST RESULTS (see Note 1)

Analysis	P (lb/A)	K (lb/A)	Ca (lb/A)	Mg (lb/A)	Zn (ppm)	Mn (ppm)	Cu (ppm)	Fe (ppm)	B (ppm)	S.Salts (ppm)
Result	19	236	1867	379	4.2	9.6	0.5	15.0	0.3	102
Rating	M-	H	H	VH	SUFF	SUFF	SUFF	SUFF	SUFF	L

Analysis	Soil pH	Buffer Index	Est.-CEC (meq/100g)	Acidity (%)	Base Sat. (%)	Ca Sat. (%)	Mg Sat. (%)	K Sat. (%)	Organic Matter (%)
Result	5.8	6.17	7.9	17.3	82.7	59.1	19.8	3.8	4.2

Results

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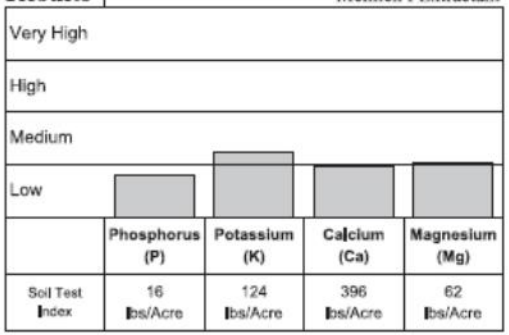
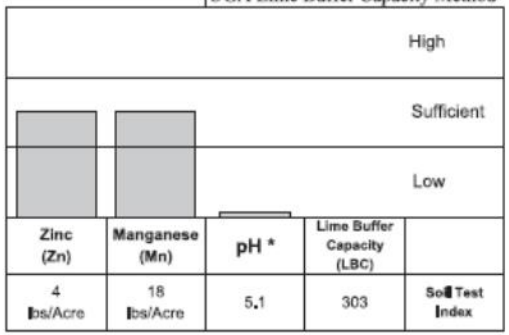


UGA Lime Buffer Capacity Method*



Recommendations

Limestone: 55 pounds per 1000 square feet

Recommended pH: 6.0 to 7.0

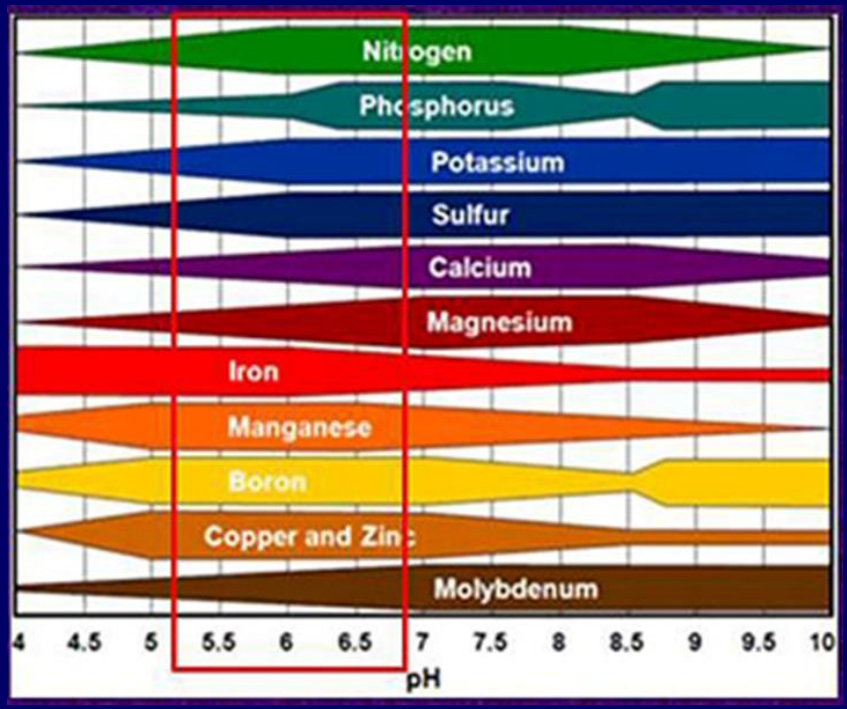
#2.

NUTRIENTS ESSENTIAL FOR NORMAL GRAPEVINE GROWTH AND DEVELOPMENT

Obtained from air and water	Macro-nutrients	Micro-nutrients
Carbon (C)	**Nitrogen (N)**	Iron (Fe)
Hydrogen (H)	**Phosphorus (P)**	Manganese (Mn)
Oxygen (O)	**Potassium (K)**	Copper (Cu)
	Calcium (Ca)	Zinc (Zn)
	Magnesium (Mg)	**Boron (B)**
	Sulfur (S)	Molybdenum (Mo)
		Others (?)

Lime and nutrient additions

Corrections easier to make at this point than after vines are planted and trellis is installed



Soil pH adjustment

- Pre-planting, incorporate applied lime before establishing cover crop
- Blend with any needed macro- and micronutrients
- Grapes tolerate a fairly wide pH range (5.5 – 7.0), but some issues can emerge if test results are on the edges here
- Sulfur fungicides, some acidifying fertilizers, and rainfall (SE US) reduce soil pH over time. Need to repeat soil testing – every 2 or 3 years
- Unincorporated lime takes many, many years to have any impact on soil pH
- Calcitic vs. dolomitic limestone

DOLOMITIC LIMESTONE (8-20% Mg)

Dolomitic lime recommended when soil Mg levels are low; otherwise calcitic or “ag lime” generally recommended.

The amount of magnesium contained in dolomitic lime is expressed as percent magnesium carbonate (determine from supplier). Conversion to elemental magnesium (Mg) is as follows:

Example: Lime contains 30% magnesium carbonate

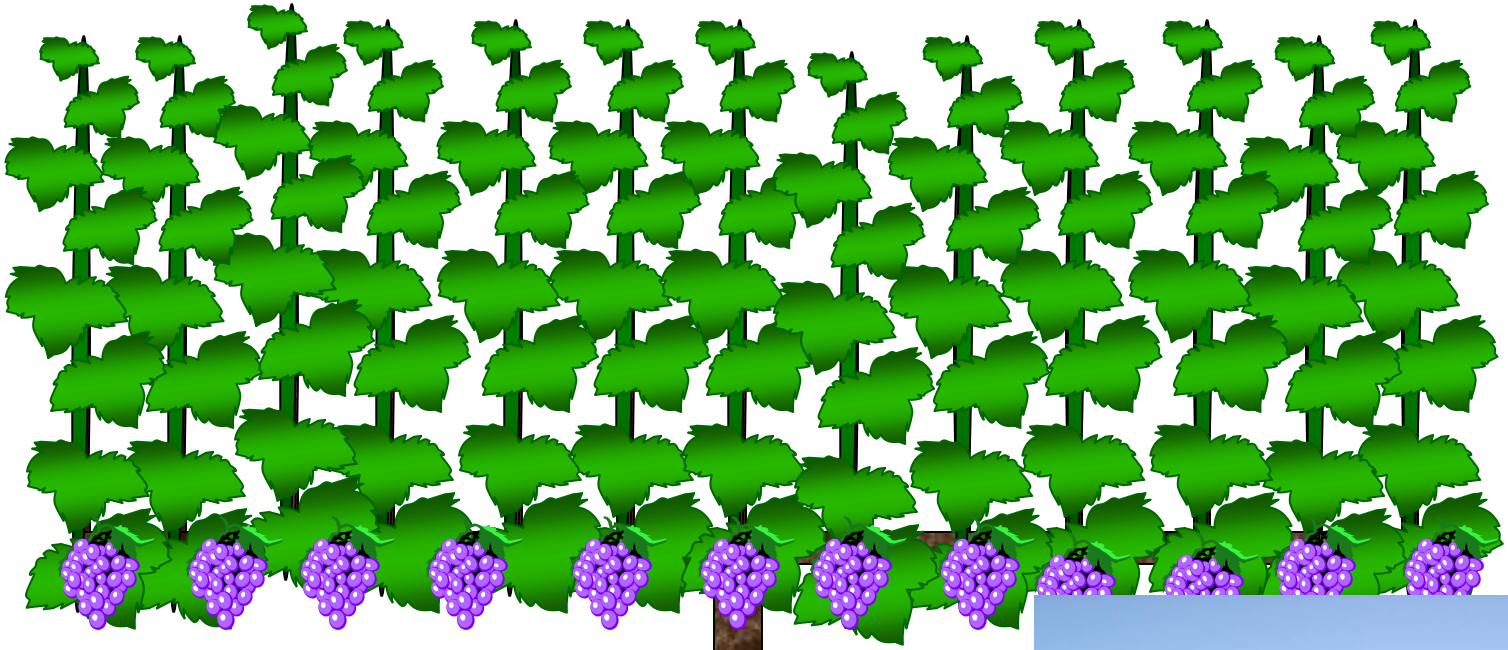
0.30 X 0.29 X 2000 lbs/ton = 174 lbs of Mg per ton

Newly-planted vines (year one)

Assuming adjustments made in pH and nutrients prior to planting, a small amount of nitrogen may advance vine development in first year, if soil moisture is not lacking.

Example: 15 lbs of actual N per acre applied as soluble fertilizer (e.g. calcium nitrate) around individual vines or via fertigation. Apply after root development commences. Cost is minor, other than time involved.

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

PLANT TISSUE ANALYSIS

Tissue: leaf petioles from leaves opposite cluster if taken at bloom

Timing: Bloom, mid-summer, or véraison work for routine analysis

Rinse the samples with clean water then dry them.

Number: 75-100 petioles

Labs: University of Georgia; commercial labs (e.g., Waypoint Analytical)

Interpretation..

We are moving towards a veraison sampling of vineyards for “routine” sampling

Veraison 40-60% color change

Trouble-shooting suspected nutrient deficiencies

Are these nutrient deficiencies, viruses, or phytotoxicity?

Example of plant tissue analysis results

Report Number
15-276-0011

Lab No:
276102

Waypoint ANALYTICAL

7621 Whitepine Road, Richmond, VA 23237
Main 804-743-9401 ° Fax 804-271-6446
www.waypointanalytical.com

PLANT ANALYSIS

Customer Account Number : 77395

Send To : VPI & SU - TONY WOLF
RESEARCH 7 EXT CTR
595 LAUREL GROVE RD
WINCHESTER VA 22602

Grower :
ISV

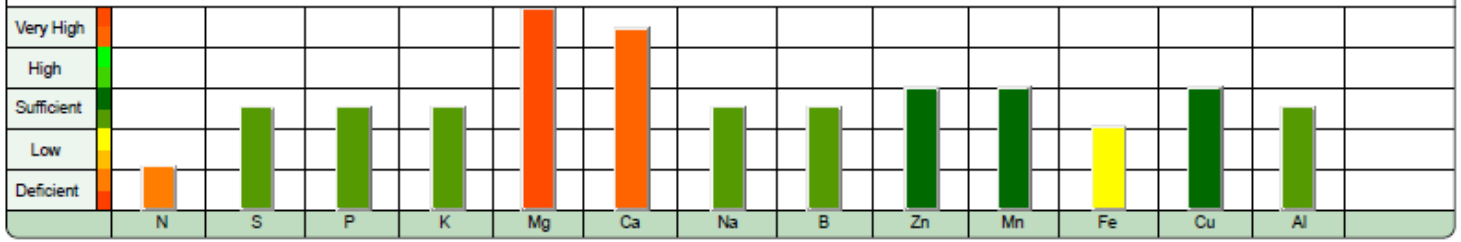
Report Date : 9/22/2015
Page 1 of 1

Field id:
Sample Id : **28-11**

Crop : **Grape petioles**
Growth Stage : **Full-bloom**

	Nitrogen %	Sulfur %	Phosphorus %	Potassium %	Magnesium %	Calcium %	Sodium %	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm
Analysis	0.61	0.19	0.33	1.70	1.00	3.05	0.06	32	75	85	33	8	5
Normal Range	1.60 2.79	0.16 0.28	0.20 0.59	1.50 4.99	0.13 0.39	0.40 2.49	0.00 0.20	25 50	20 100	18 100	40 180	5 10	0 250

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Ca/B	Fe/Mn
Actual Ratio	3.2	0.4	1.7	44.0	1.7	200.0	953.1	0.4
Expected Ratio	10.0	0.7	1.8	65.8	12.5	550.0	384.9	1.9



Comments :

02027) IRON - Low/deficient apply a foliar application of Fe at the rate of ¼ to 1# Fe per acre in 30 gal. of water. If chelated material is used, apply according to manufacture specifications.

02015) NITROGEN - Deficient or low due to inadequate N fertilization, excessive rainfall, and/or ineffective N application. Additional nitrogen may be supplied to the crop with sidedress or topdress applications or in irrigation water. Refer to local/state recommendations or contact the lab for supplemental N recommendations.

02084) Additional nitrogen may be supplied to the crop with sidedress or topdress applications or in irrigation water. Apply at the rate of 20 to 50# per acre. Repeated applications may be necessary.

02114) One or more nutrients are very high at this time. Please monitor.

Target values for soil, bloom petioles, and veraison petioles

	Soil		Bloom petioles		Veraison petioles	
Nitrogen	---		1.2 – 2.2	%	0.75 – 1.0	%
Phosphorus	20 - 50	ppm	0.17 – 0.30	%	0.14 – 0.30	%
Potassium	40 - 50	ppm	≥ 1.5	%	0.8 – 1.0	%
Calcium	500 - 2,000	ppm	1.0 – 3.0	%	1.0 – 2.0	%
Magnesium	100 - 250	ppm	0.3 – 0.5	%	0.35 – 0.75	%
Boron	0.30 - 2.0	ppm	25 – 50	ppm	25 - 50	ppm
Iron	20	ppm	30 – 100	ppm	30 - 100	ppm
Manganese	20	ppm	25 – 1,000	ppm	100 – 1,500	ppm
Copper	0.5	ppm	5 – 15	ppm	5 - 15	ppm
Zinc	2.0	ppm	30 – 60	ppm	30 - 60	ppm
Molybdenum		ppm	0.5	ppm	0.5	ppm
Organic matter	3 – 5	%				
pH	5.5	V. Labrusca	PPM X 2 = lbs/acre			
	6.0	Hybrids				
	6.5	V. vinifera				

Nitrogen

Role of nitrogen

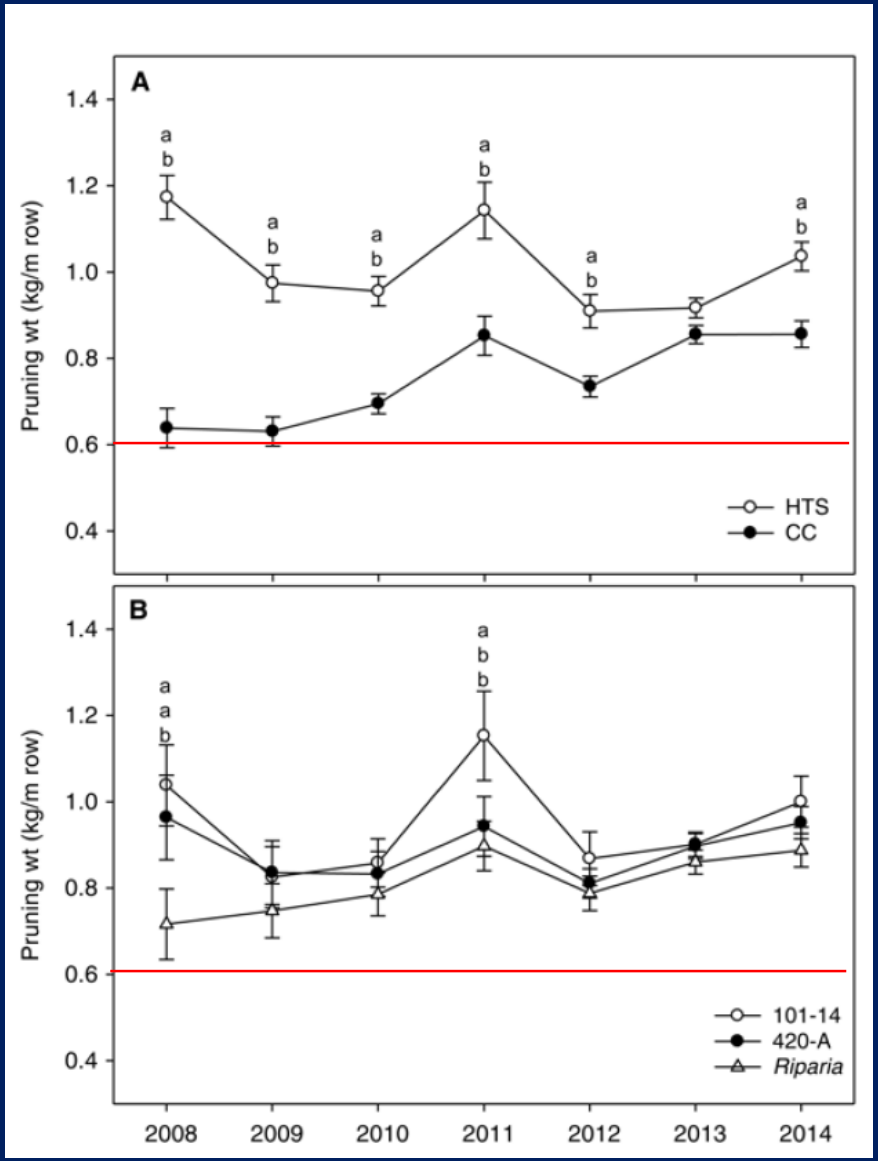
- Nucleic acids $\rightarrow$ DNA $\rightarrow$ Genes
- Amino acids $\rightarrow$ Proteins $\rightarrow$ Enzymes
- Chlorophyll $\rightarrow$ Light interception
- Hormones $\rightarrow$ Communication
- Secondary metabolites $\rightarrow$ Color, flavor

NITROGEN ISSUES

- Assessing need
  - Visual (vine size, leaf color, trellis fill)
  - Tissue analysis (timing, tissue, relationship to standards (total N assessed at bloom-time (1.2 to 2.1% N) or veraison (> 0.75 – 1.0%)
  - Cane pruning weights (e.g., < 0.2 lbs/ft canopy)
  - Weed and intra-row cover crops

Example of under-trellis cover crop
combined with row middle cover crop

Cane pruning weights are a useful indicator of vine balance



NITROGEN ISSUES?

- Use of competitive (for water) cover crops has also increased competition for nitrogen
- Vine capacity can be reduced to insufficient levels in some cases
  - Alter herbicide width
  - Increase fertilization
- Low (< 140 mg/L) YAN levels in resultant musts

Sauvignon blanc experiment
Glen Manor Vineyards (2011-2016)

- **Control**– no nitrogen
- **Low calcium nitrate rate** = 27 lbs/A at bloom (30 kg/ha)
- **High calcium nitrate rate** = 27 lbs/A at bloom + 27 lbs/A at 6 weeks post bloom (60 kg/ha total)
- **Foliar urea**– 32 lbs/A total– applied incrementally and weekly for 8 weeks

Russ Moss
DeAnna D'Attilio

Crop per vine (lbs) at GMV Sauvignon blanc as function of nitrogen fertilization

Vines spaced 7 feet apart in the row and trained to open lyre (14 feet of canopy)

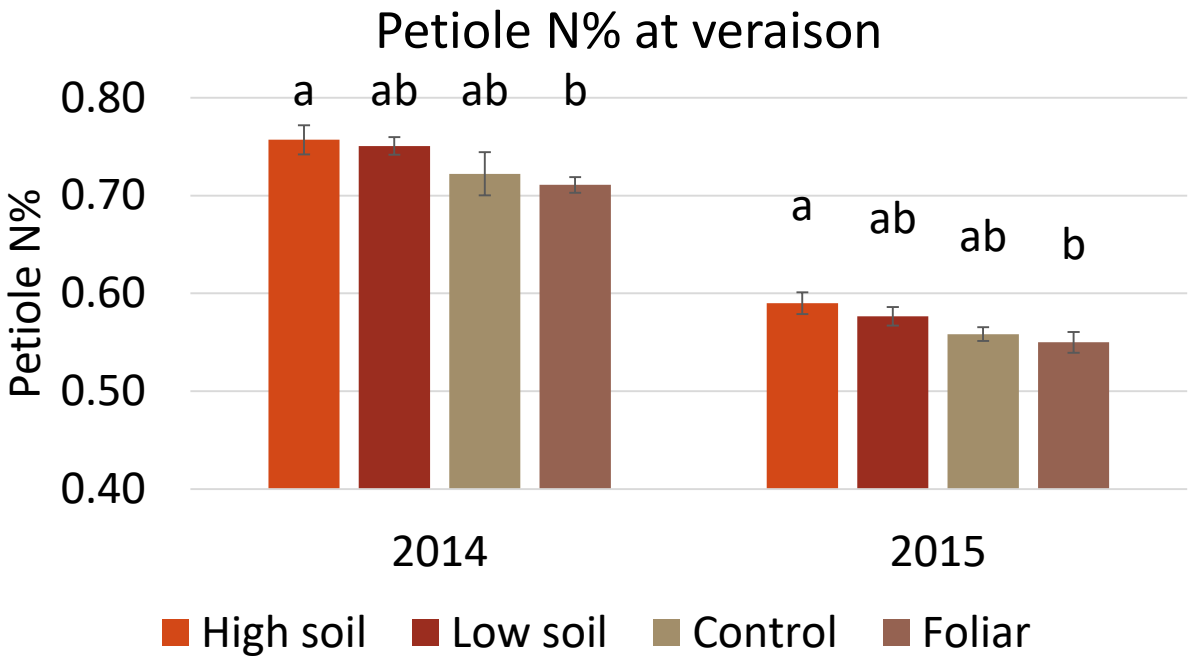
	2011	2012	2013	2014	2015
Control	13.4	11.5	20.0	22.7 b	26.6 c
30 N, soil	14.2	11.9	21.6	28.0 a	32.7 ab
60 N, soil	14.3	10.8	23.4	29.3 a	36.5 a
30 N, foliar	13.2	9.9	20.5	25.6 ab	31.1 b

Summary: soil-applied N increased crop relative to rate. Foliar N was somewhat less effective, but this likely due to lower rate of N used.

Cane pruning weights (kg/m of canopy) at GMV Sauvignon blanc as function of nitrogen fertilization [vines had 4.8 m of cordon (open lyre)] Optimal range = 0.30 – 0.60 kg/m

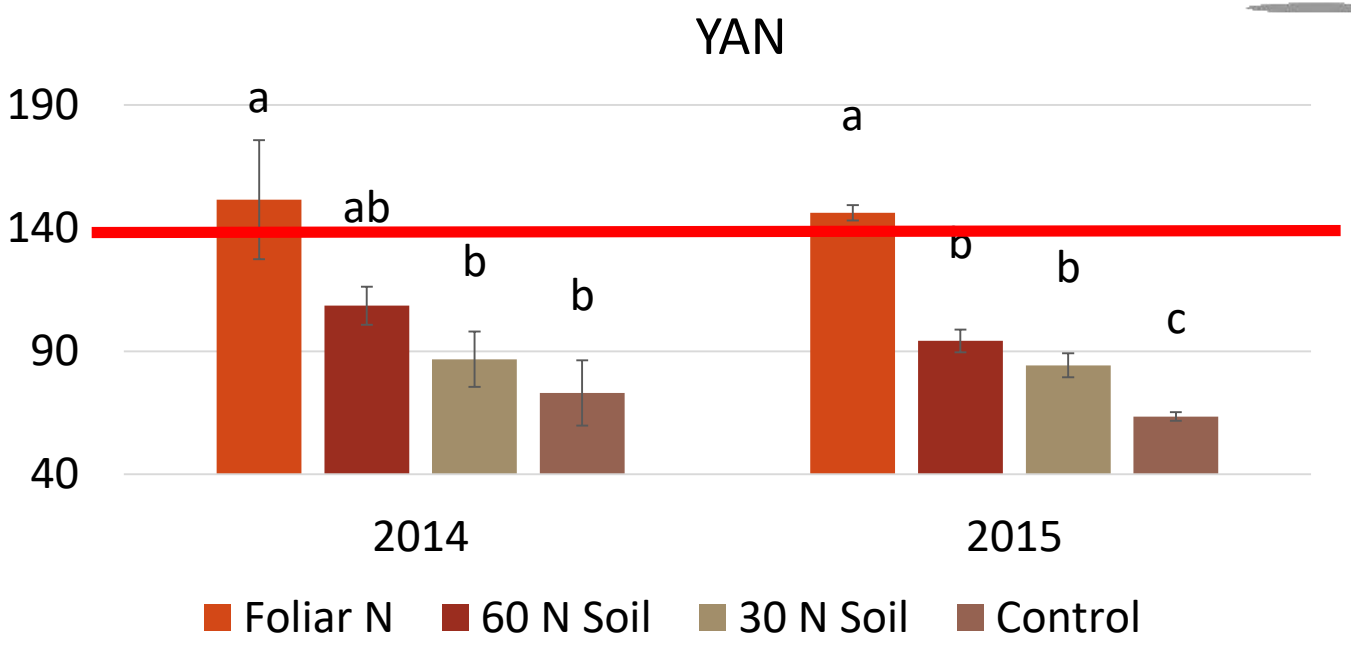
	2011	2012	2013	2014	2015
Control	0.31	0.29	Nd	0.19 c	0.22 b
30 N, soil	0.35	0.31	Nd	0.27 ab	0.31 ab
60 N, soil	0.32	0.29	Nd	0.33 a	0.40 a
30 N, foliar	0.28	0.24	Nd	0.22 bc	0.29 ab

GMV Sauvignon blanc



- High soil: 60 kg N/ha
- Low soil: 30 kg N/ha
- Foliar: 30 kg N/ha
- Control: no N

GMV Sauvignon blanc



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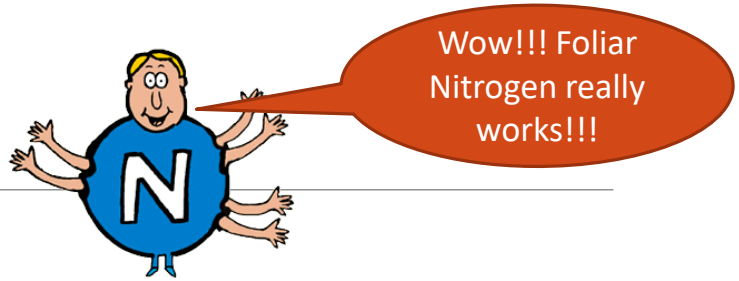
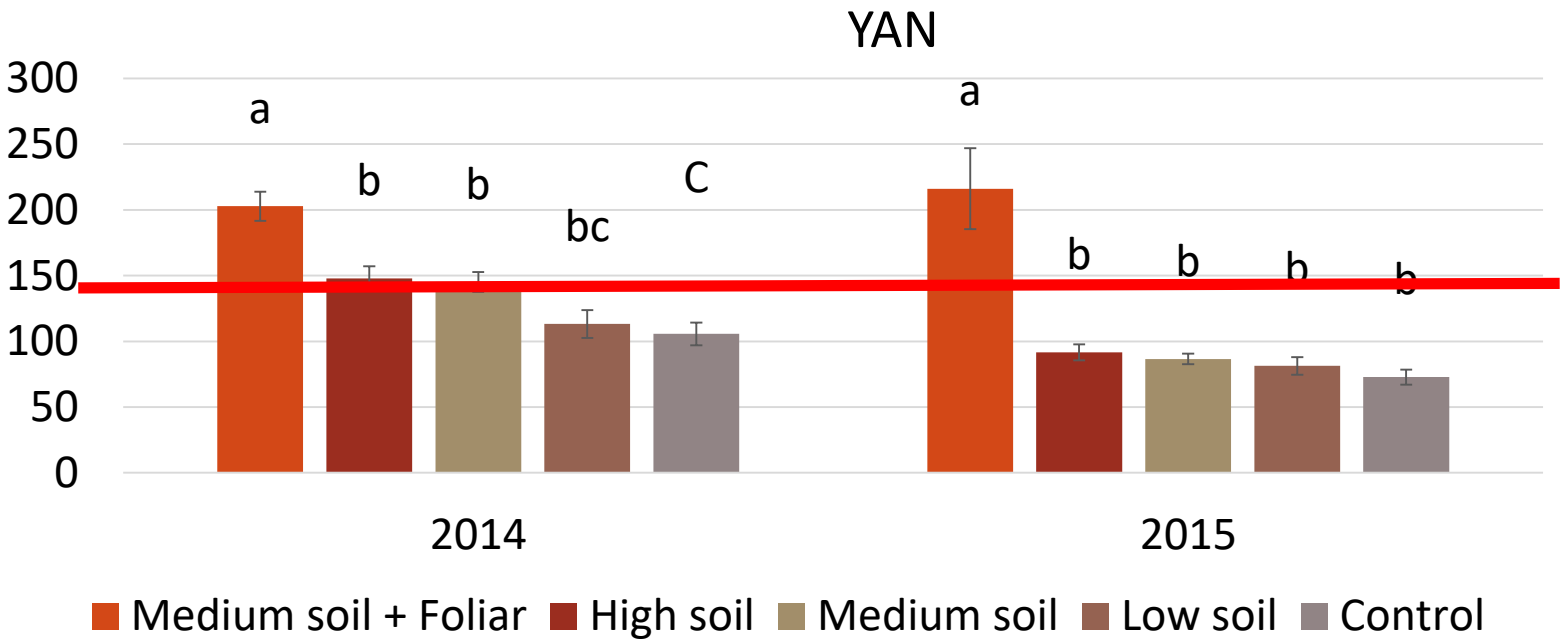




- High soil: 60 kg N/ha
- Medium soil: 45 kg N/ha
- Low soil: 30 kg N/ha
- Medium soil + foliar: 45 kg N/ha soil + 15 kg N/ha foliar
- Control: no N

Conclusions / recommendations

- Over time, cover crops led to reduced vine capacity, in part this appeared due to reduced N status of vines
- Soil-applied nitrogen effectively increased vine capacity
- Foliar-applied nitrogen was more effective at increasing must levels of Yeast-Assimilable Nitrogen (YAN) [PAN and NH4]
- Although we did not see increased fungal disease incidence with foliar N application, it is a potential to watch out for.

- Cover crops suppress soil erosion
- Adjustments were made in vine N fertilization to benefit the vines and not necessarily feed the cover crops
- Consider foliar N (urea, about ~ 5 lbs actual N/acre in at least 50 gallons of water/acre). Some burn observed at > 7.5 lbs/acre. Application at or around véraison.

NITROGEN ISSUES

- Correction
  - Materials
    - basis of cost (urea likely least expensive)
    - compost, manure, chicken litter, other organics
    - other nitrate fertilizers (MAP, DAP, CalNitrate – expensive, but have their place)
  - Timing
    - relationship to periods of root growth
    - recognition that some of benefit not observed until second year; post-harvest application --foliar or soil
    - multiple, small applications rather than single large
    - fertigation

Potassium (K)

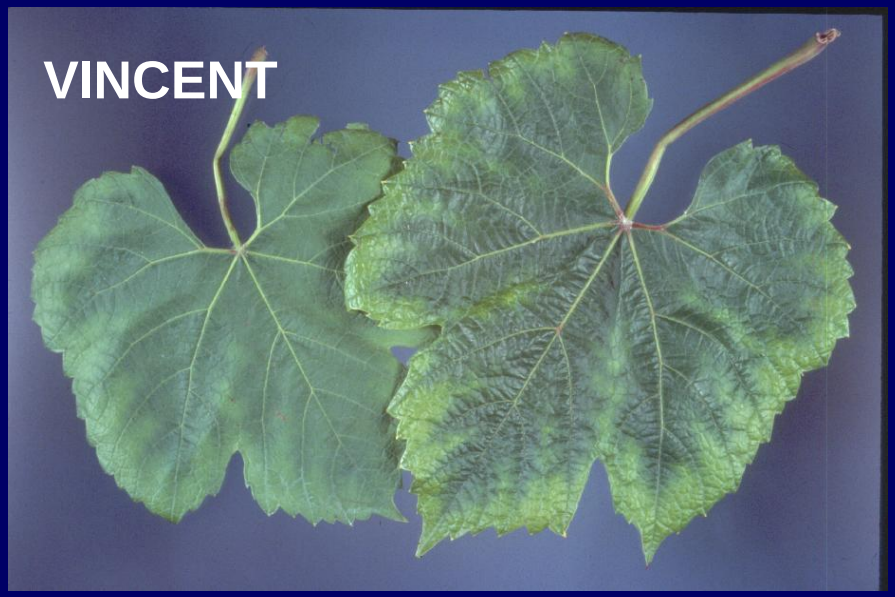
- Phloem loading and translocation of assimilates (sucrose/H^+ co-transport)
- Maintenance of water status
- Enzyme activation (> 60 reactions)
- Photosynthetic processes

  neutralization of electrical charge

  ATP synthesis

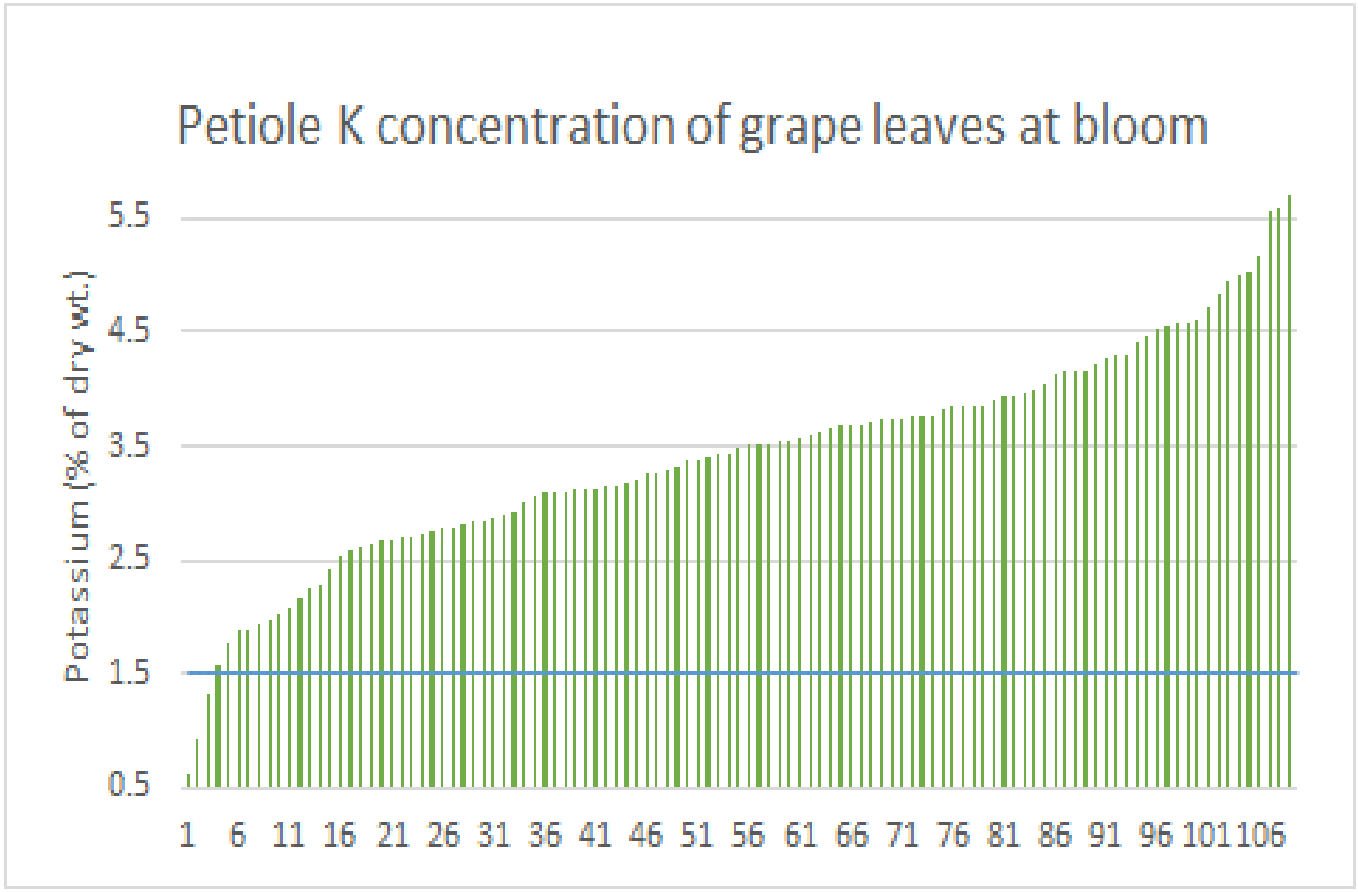
TEMPRANILLO

Potassium deficiency symptoms

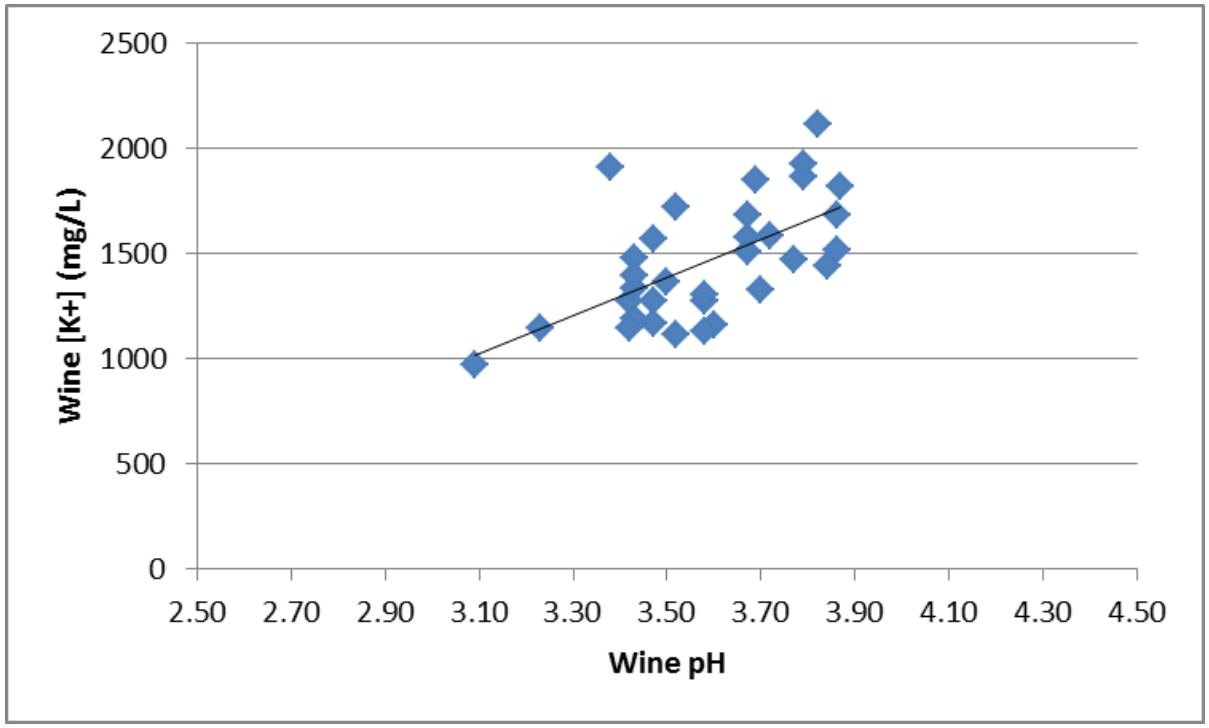


Situations where added K might be needed

- Young vines (e.g., < 3 years old)
- Soils inherently low in available K (soluble and readily exchangeable)
- Soil tests < 40 ppm (80 lbs/acre) K
- Drought conditions (irrigate)
- High soil pH (>7.0) or under conditions of very high exchangeable Mg or Ca

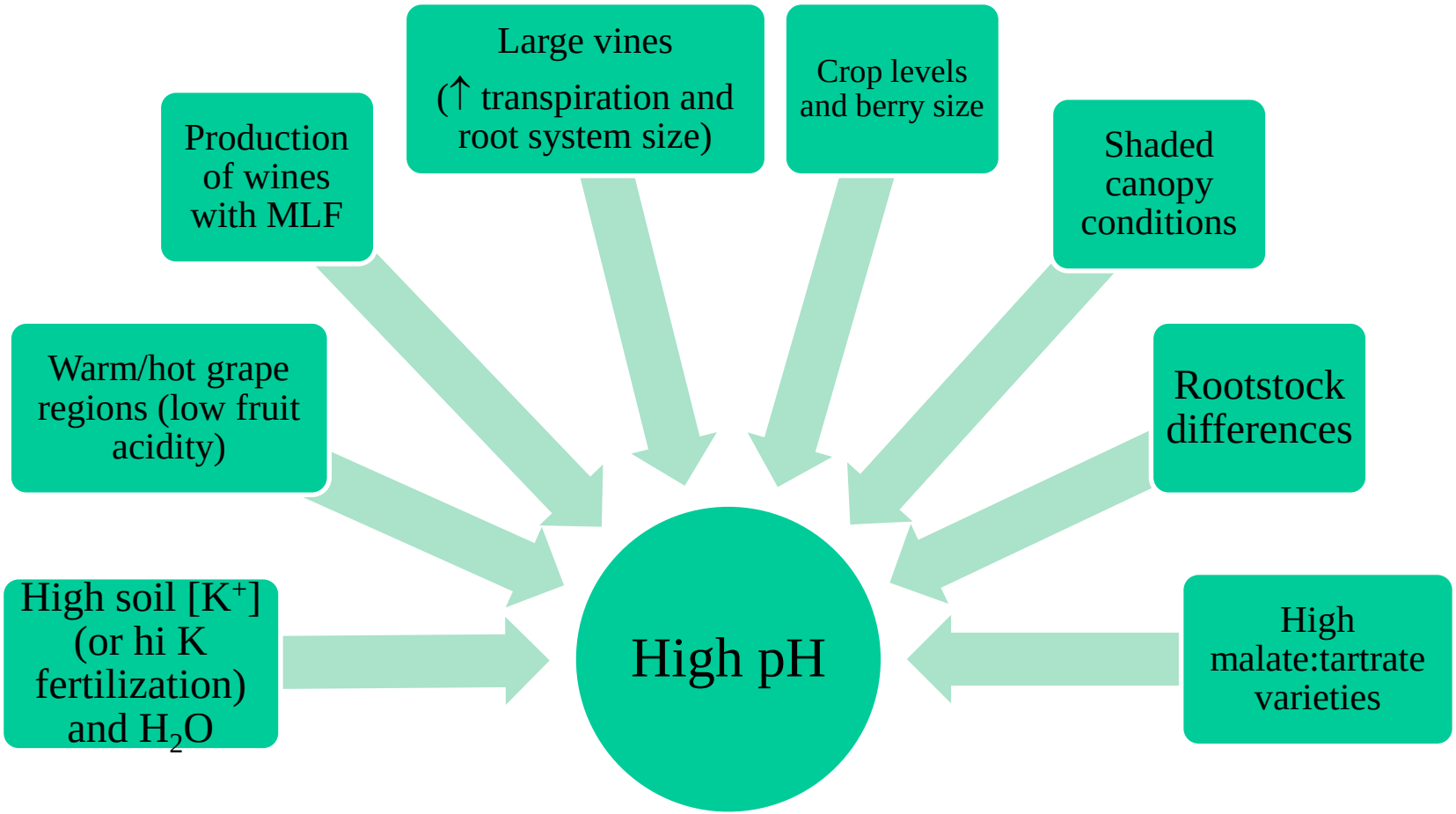


Leaf petiole K concentration of 110 random, commercial samples collected at bloom between 2003 and 2015. The line at 1.5% is the upper limit of tissue K concentration associated with acceptable K concentration in Virginia.



Data from Zoecklein "pH imbalance in Cabernet Sauvignon"; ASEV/ES meeting held in Virginia, March 1987. Data are from 33 Cabernet Sauvignon wines from Virginia.

High juice (wine) pH conditions

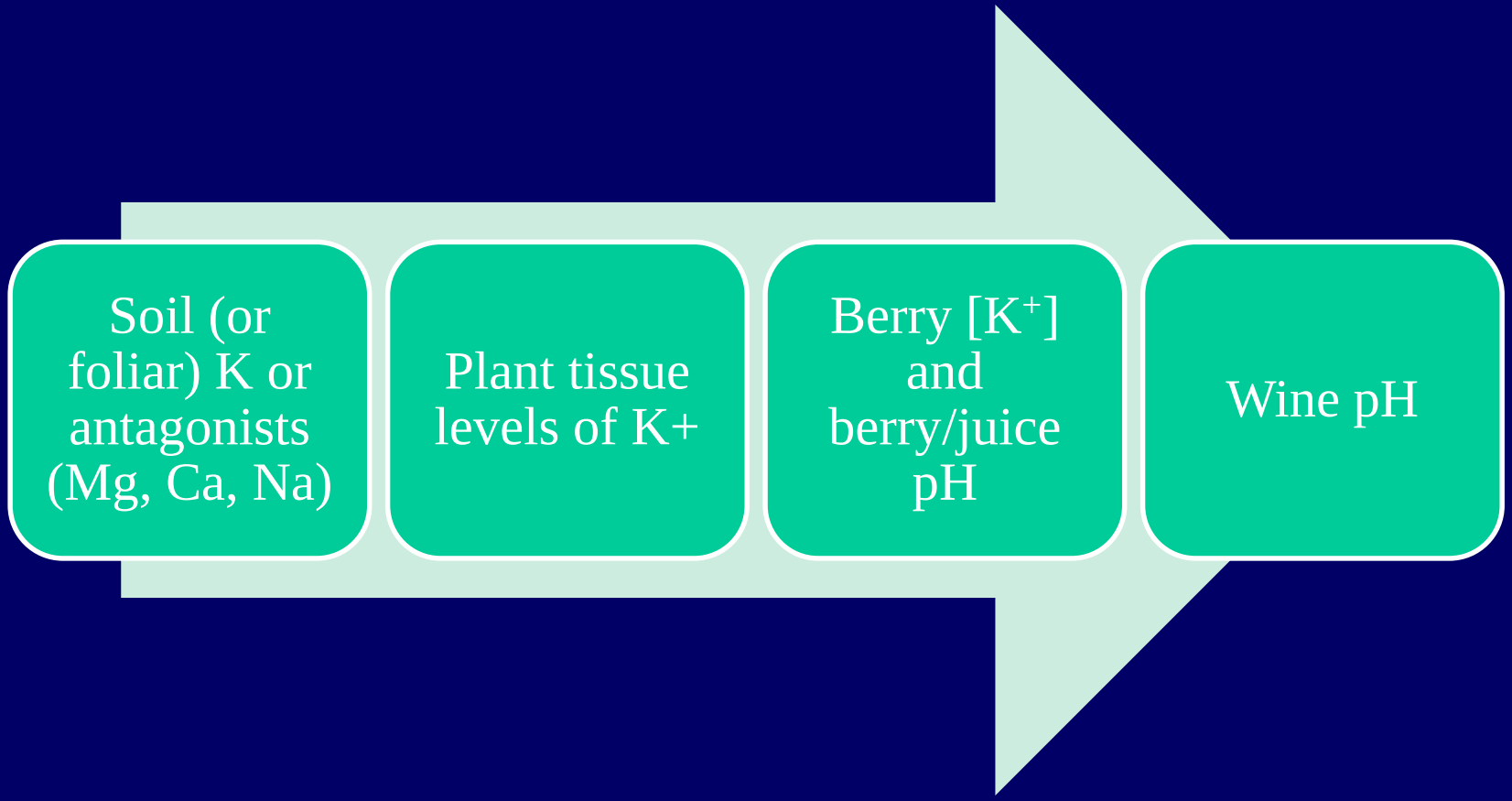


Potassium: Relationship between juice [K^+] and juice pH

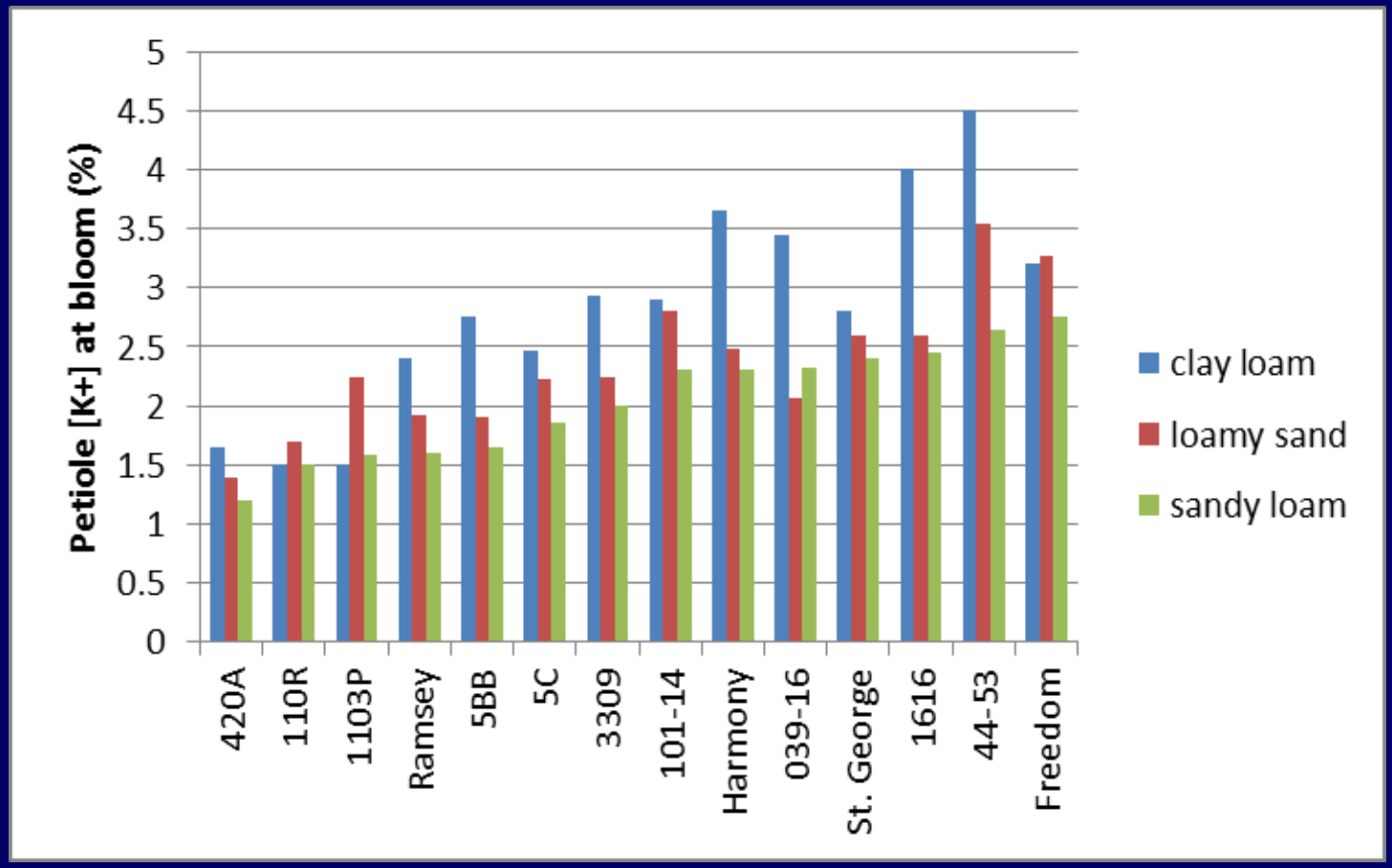
High application rates or availability of K can increase berry K^+ and can, under some conditions, elevate juice (and wine) pH.

Can juice pH be lowered by depressing K^+ uptake and/or accumulation in berries?

Potassium (Relationship between juice [K^+] and juice pH)



Effect of rootstock (and soil texture) on vine uptake of potassium.

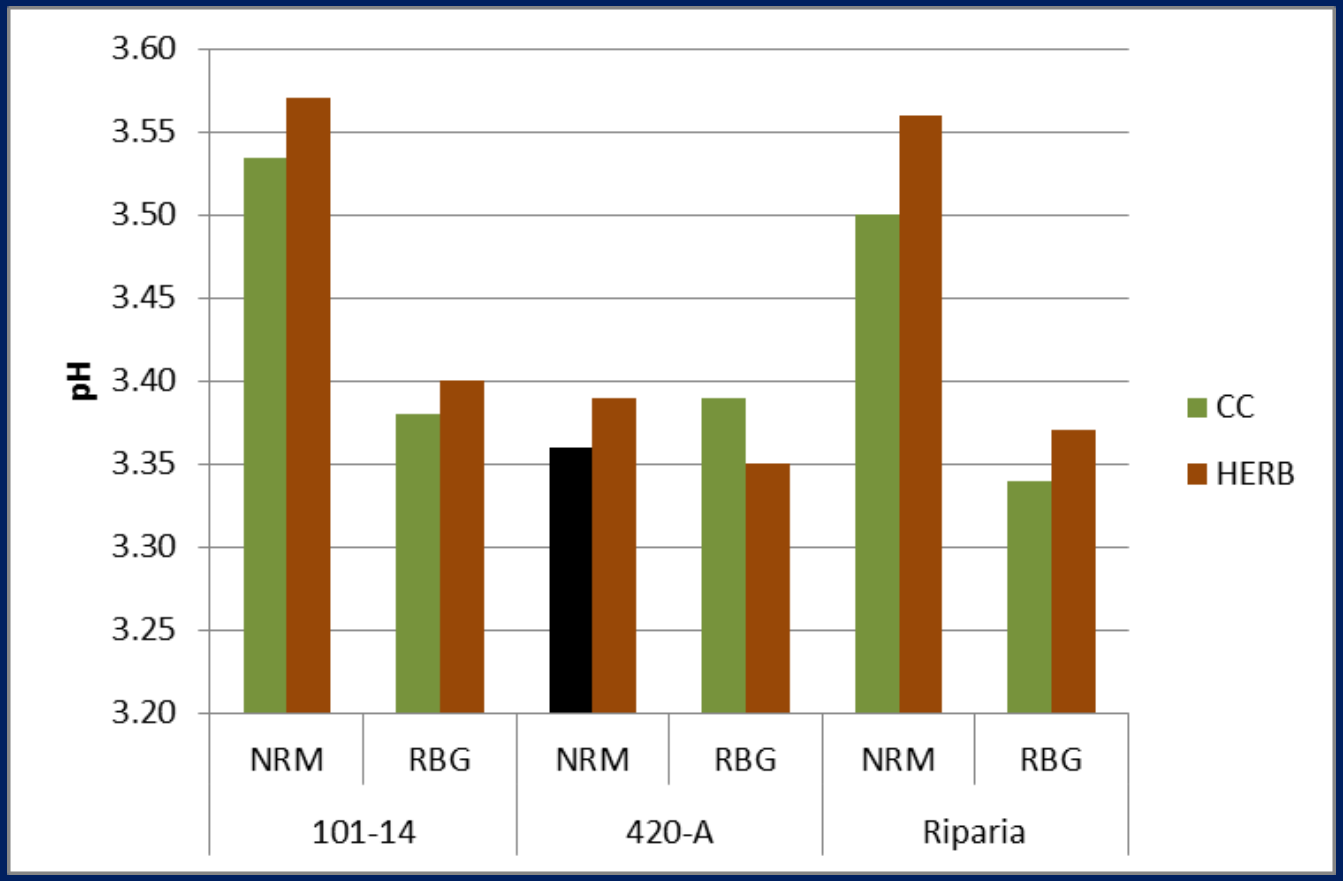


Lower petiole potassium concentration at bloom in rootstocks with *Vitis berlandieri* parentage. Am. J. Enol. Vitic. 56:163-169. Data are means of 3 sequential years. (Wolpert et al. 2005).

Average juice pH at harvest, 2012-2014, Cabernet Sauvignon, AHS AREC

Treatments:

- 3 rootstocks
- 2 floor management schemes (solid cover crop [CC] or interrow CC+ in-row Herb strip (HERB)
- 2 root manipulations: none [NRM] or rootbags [RBG]



Potential means of limiting berry K accumulation

- Choose a vineyard site with little or no 2:1 type clays
- Avoid K fertilizer application to soil
- Incorporate lime and target pH 6.5 – 7.0
- Use rootstocks that depress K uptake (e.g., 420-A)
- Consider root restriction (shallow soil or synthetic "root bags")
- Exercise perfect canopy management to limit mutual leaf shading
- Monitor vine K status visually and via plant tissue analysis to avoid potential deficiency

Avoidance and correction of potassium deficiency

- Avoid soil application of potassium if soil tests above 55 lbs/acre (28 ppm)
- Small quantities of potash – either potassium chloride or potassium sulfate post-planting
- Or use a foliar potassium fertilizer in first year or two
- Potassium deficiency very rare in older, established vineyards

MICRO-NUTRIENTS

VERY SMALL CONCENTRATIONS NEEDED BY THE PLANT FOR NORMAL GROWTH AND DEVELOPMENT

Iron
Manganese
Copper
Zinc
Boron
Molybdenum

SUMMARY

- Promoting and sustaining balanced vine nutrition is part of good vineyard management
- Starts in pre-plant phase and includes appropriate pH adjustment
- Three-part process thereafter: visual assessment, soil, and plant tissue analysis
- Corrective measures are generally well-tested and effective, if followed