Grapevine Nutrition:
(Tissue Tests & Guidelines)

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Managing Nutrition in Grapes

1. Scouting Fields for Symptoms & Monitoring Growth.

2. Routine Analysis – **Leaf** or Petiole tests (? Soil tests ?).

3. Targeted Sampling & Analysis.

4. Altering Nutrient Supply to Vines.

Is Soil Fertility a Good Predictor of Grapevine Nutrient Status?

Nutrient	Soil Test Values (ppm)	Leaf Test Values (% or ppm)	Correlation Coefficient (r)
N	4.0		0.360
P	8		0.138
K	14		0.270
Ca	260		0.323
Mg	49		0.228
Fe	9 - 141	53 - 158	-0.159
Mn	5 - 60	118 - 288	0.200
B	0.1 - 0.8	17 - 216	-0.097
Zn	0.2 - 9.1	15 - 130	-0.160
Cu	0.5 - 5.0	13 - 26	0.215

NO

29 self-rooted Pinot noir/Chardonnay Blocks - Schreiner & Linderman 2005

Brief History of Tissue Nutrient Testing in Vineyards

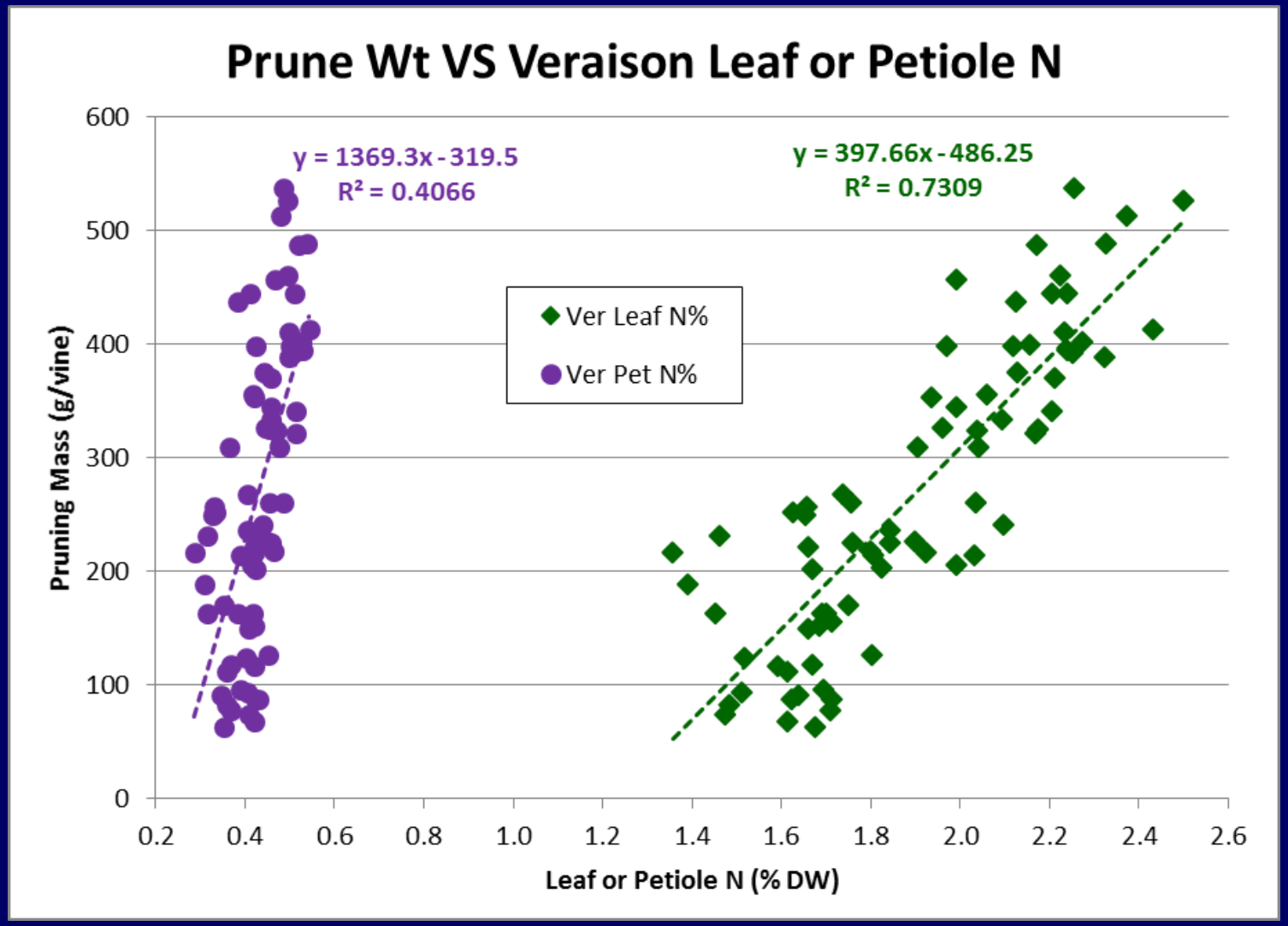
- French were first (1920's) – whole leaf blade to diagnose adequate NPK, 4 times/season
- Whole blade used subsequently in Europe at 2 times (bloom, veraison).
- Work in CA (1940's) focused on petioles for N and K, then New York, Australia also used petioles (1960's and beyond).
- Petioles became widely adopted in US.
- Numerous physiologist's have questioned the reliance on petioles (as leaf blades are the metabolic work-horse of the canopy).

See Schreiner & Scagel 2017 Hortscience **52**:174

Leaf blade VS Petiole - Methods Analysis with Pinot noir

- Leaf and Petiole collected at Bloom and Veraison, separated, dried.
- Used Raw Data (experimental plot data, not means).
- Leaf Blade or Petiole N, P, & K used to predict vine responses to varying N, P & K supply using Regression.

Results - Controlled PIP Trial - 4 years



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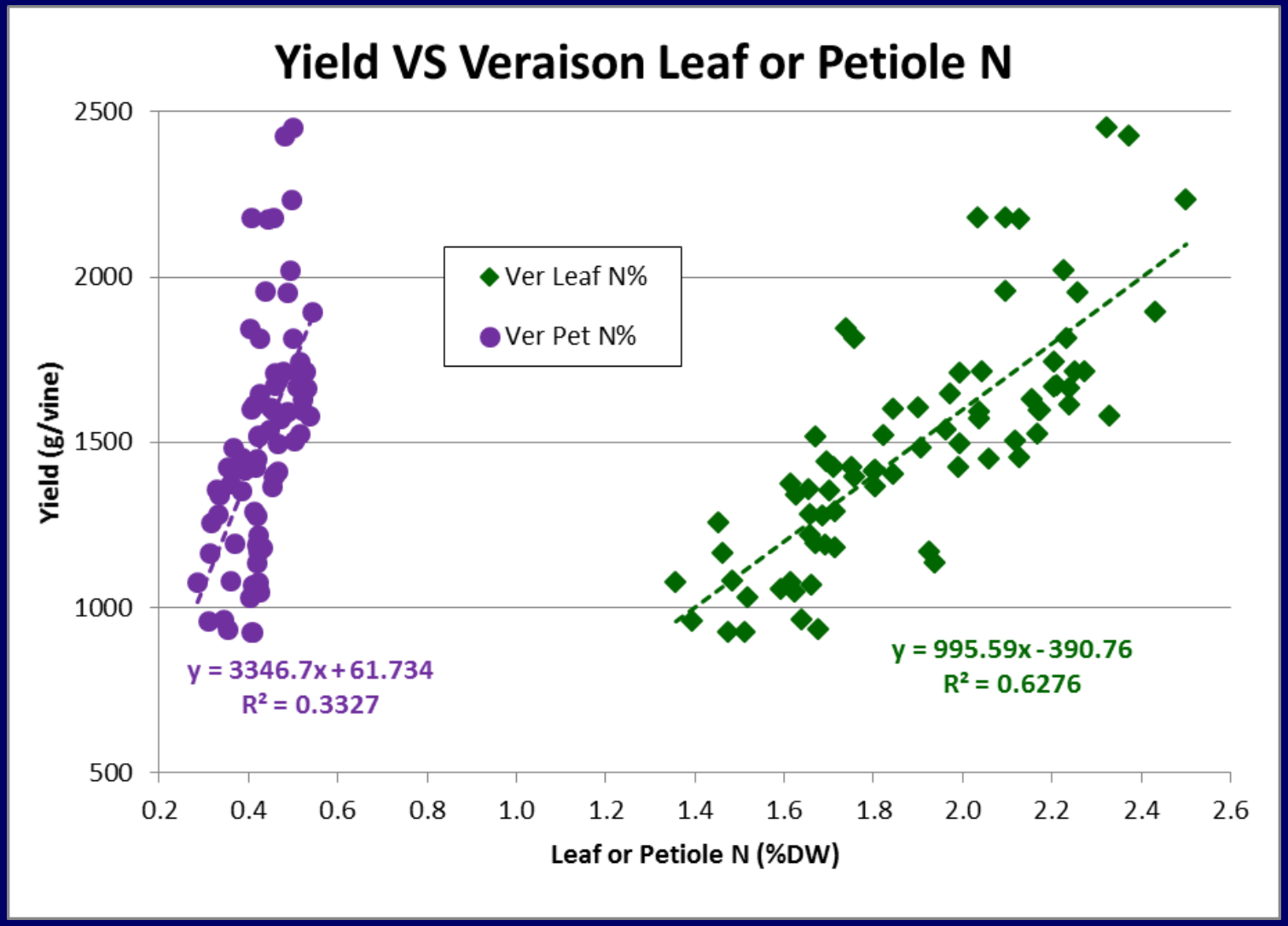

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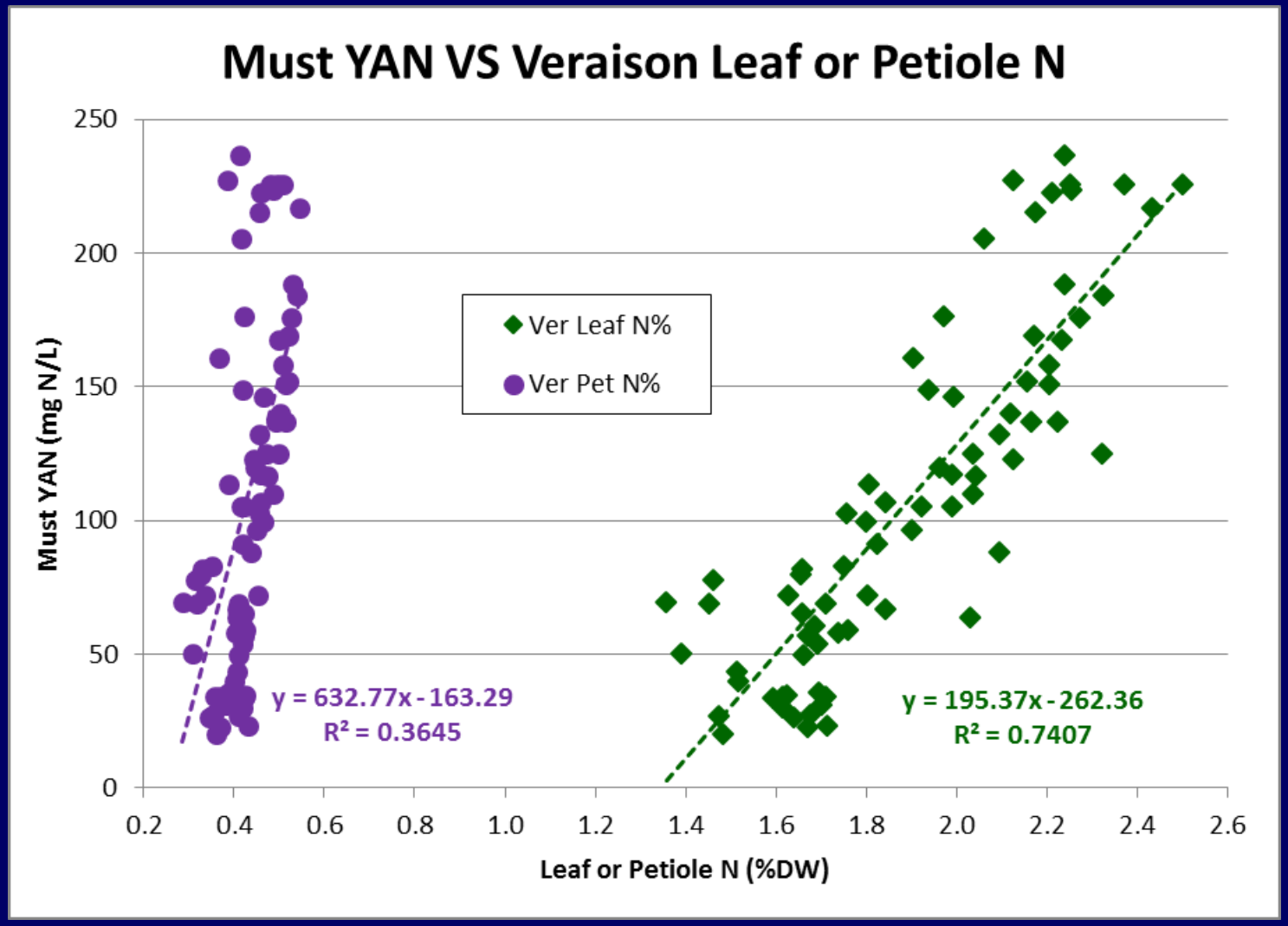
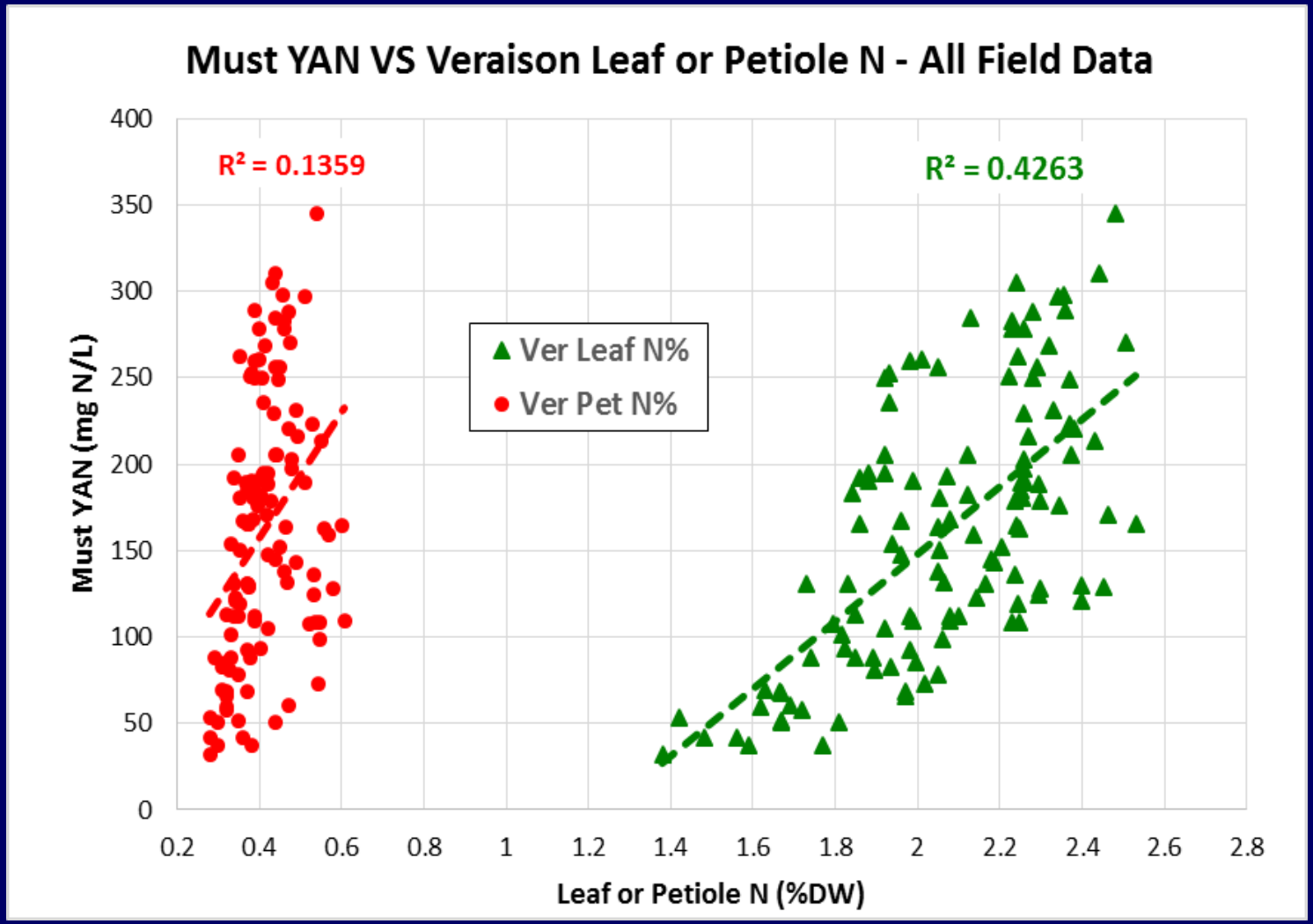


Results - Pinot noir Field YAN only



Conclusions - Leaf blade VS Petiole

- Leaf blade **N** outperformed petiole **N** in all cases that we compared.
  - Model fit significantly better for leaf blades for All Variables in PIP Trial, & for must YAN Field Data.
- Wider Variance in Petiole **N** (mainly in different years).
- P & K - blade and petiole performed equally well in this analysis (data not shown).
- **Blades should be used in routine testing of grapevine nutrients!**
- Nutrient Deficiencies in Willamette Valley (P, K, Mg) – consistently better diagnosed by blades than petioles.

Tissue Guidelines for Oregon Vineyards

			Petiole		Leaf Blade		
Nutrient	Sample timing	Units	Deficient	Excessive	Deficient	Safe/Healthy	Excessive
N	bloom	%			2.20	> 2.40	4.25
	véraison	%	0.35 - 0.40		1.80	> 2.00	2.50
P	bloom	%	0.15		0.17	> 0.20	
	véraison	%	0.05		0.10	> 0.11	
K	bloom	%	0.75 - 1.50	3.25	0.70	> 0.80	1.5
	véraison	%	0.50 - 0.60		0.60	> 0.70	1.25
Ca	bloom	%	1.0		1.0		
Mg	bloom	%	0.20		0.18	Too High	
Mn	bloom	ppm	20		20		
Zn	bloom	ppm	20 - 25		15 - 20		
B	bloom	ppm	20 - 25	125	20		250
Cu	bloom	ppm	3 - 5	25 - 50	3 - 5		

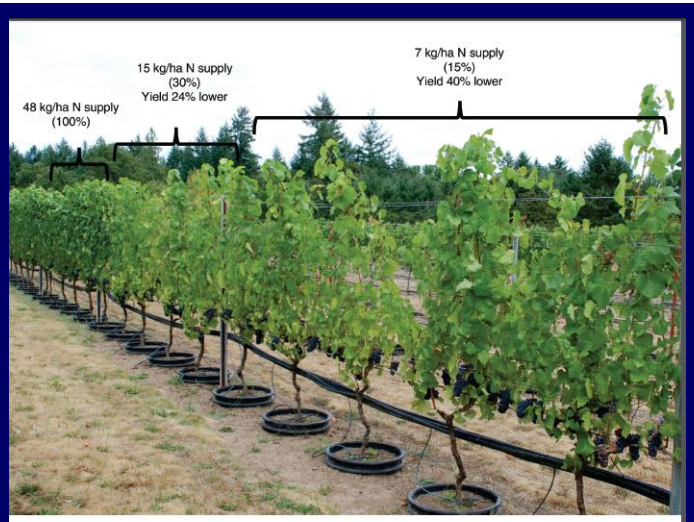
Bloom samples - opposite cluster, Veraison samples - paired basal & upper leaf

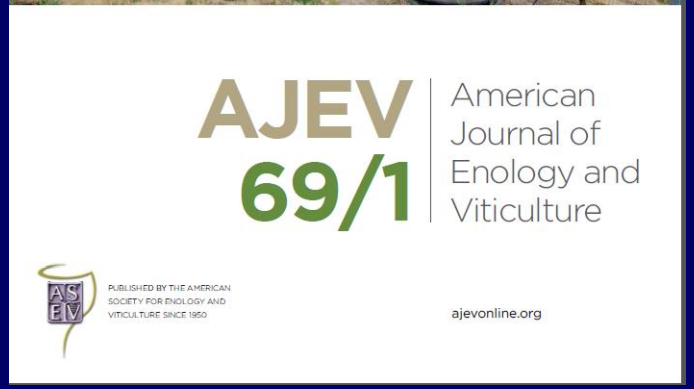
Microplot Study - NPK Requirements

Nitrogen Requirements of Pinot noir Based on Growth Parameters, Must Composition, and Fermentation Behavior

R. Paul Schreiner,[1]* James Osborne,[2] and Patricia A. Skinkis[3]

Am. J. Enol. Vitic. 69:1 (2018)





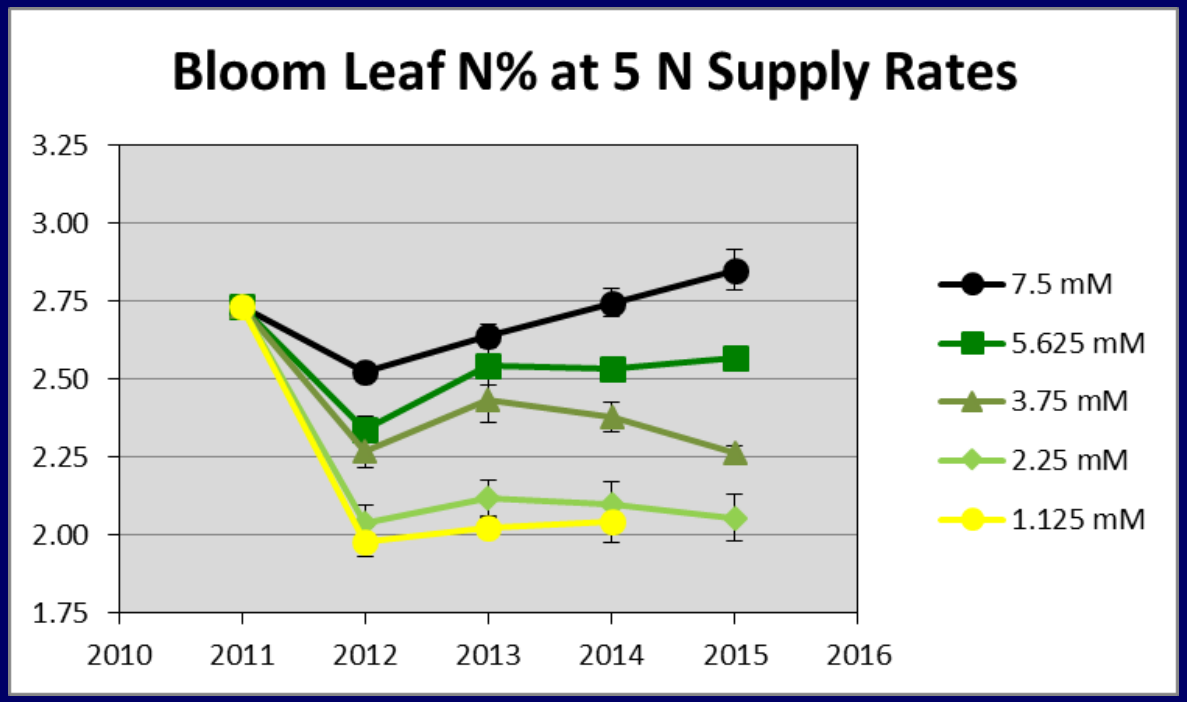
Selected for the first edition of the New Journal Cover Design for Am. J. Enol. Vitic.

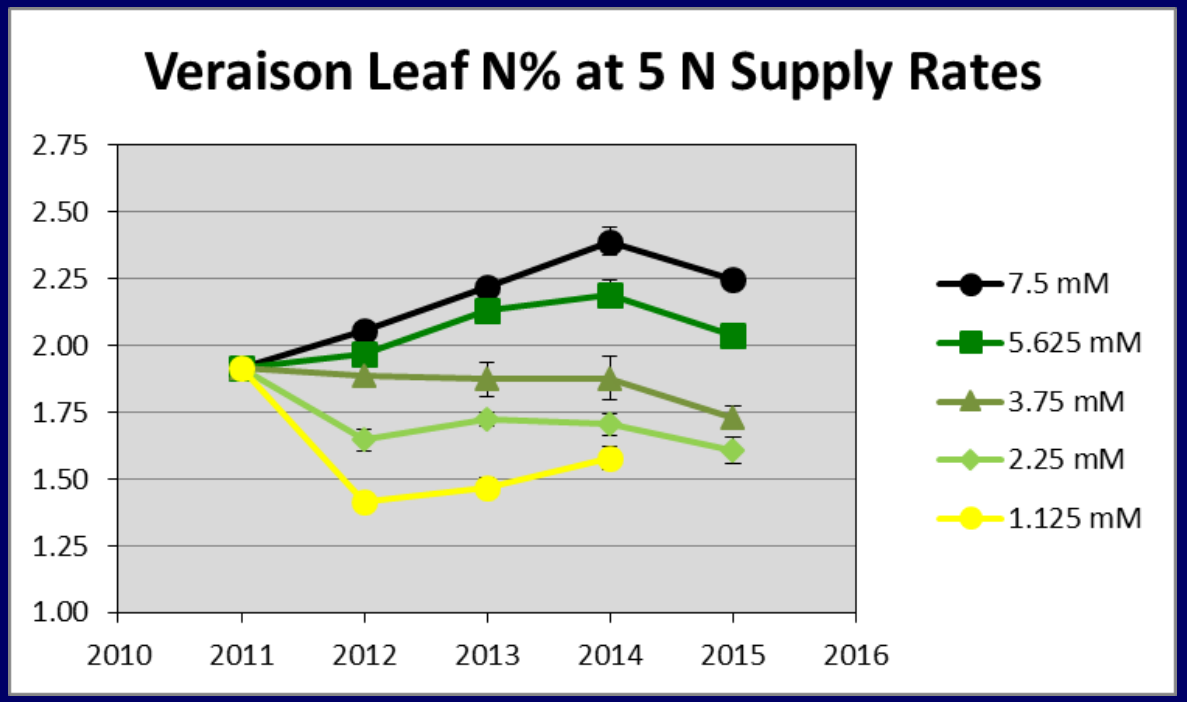
*** Best Viticulture Paper 2018 ***

NPK 2

N Supply

Target Effects





NPK 2

N Supply

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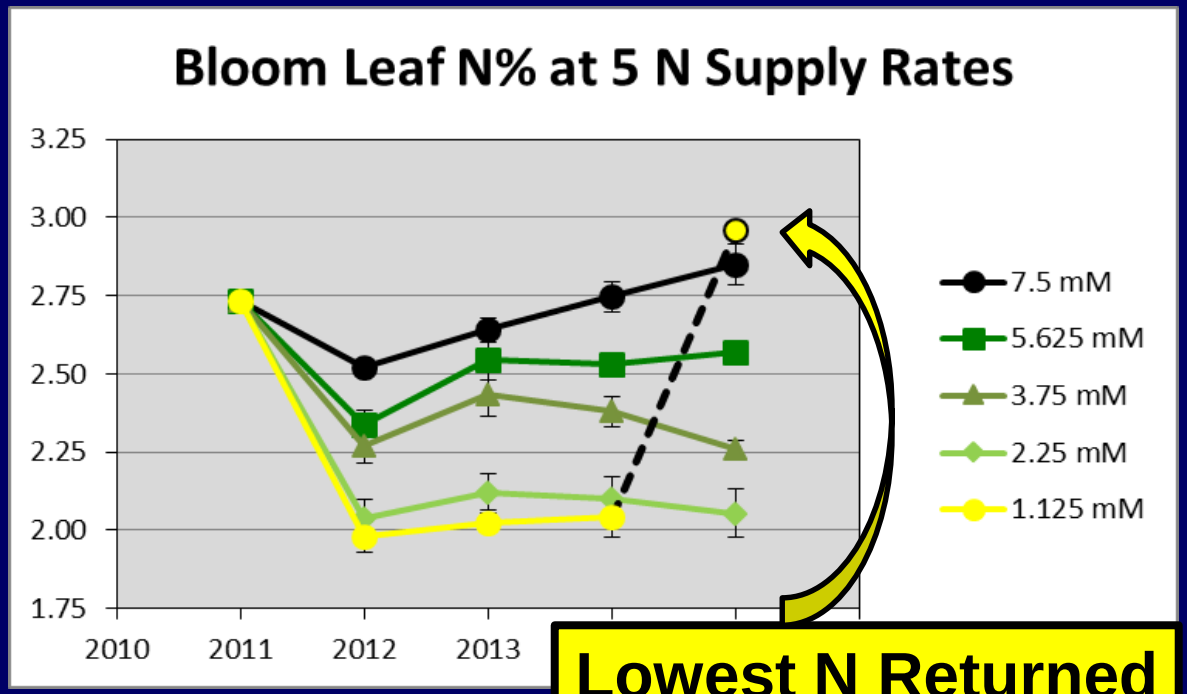
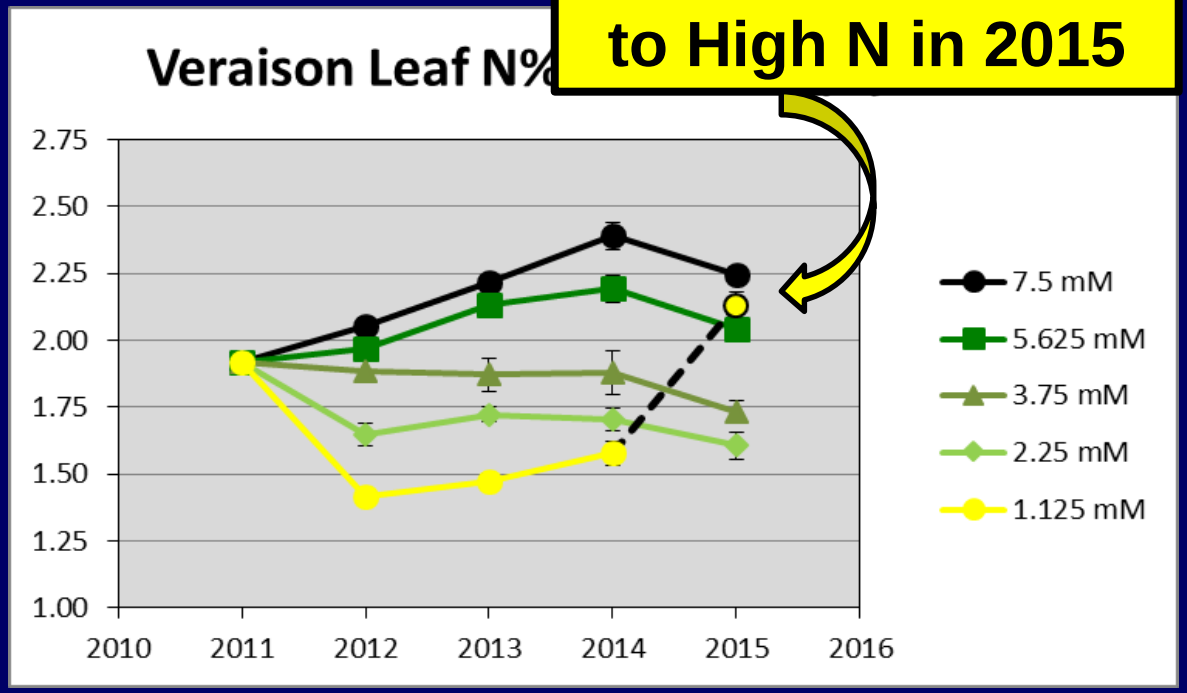


Lowest N Returned to High N in 2015

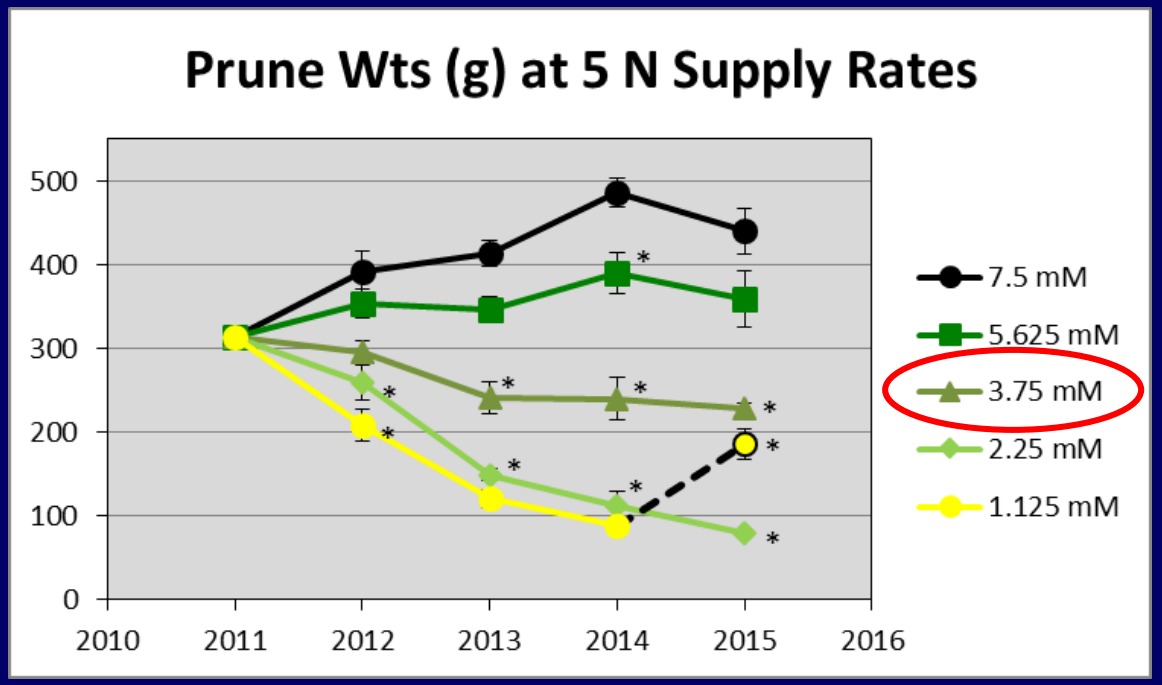


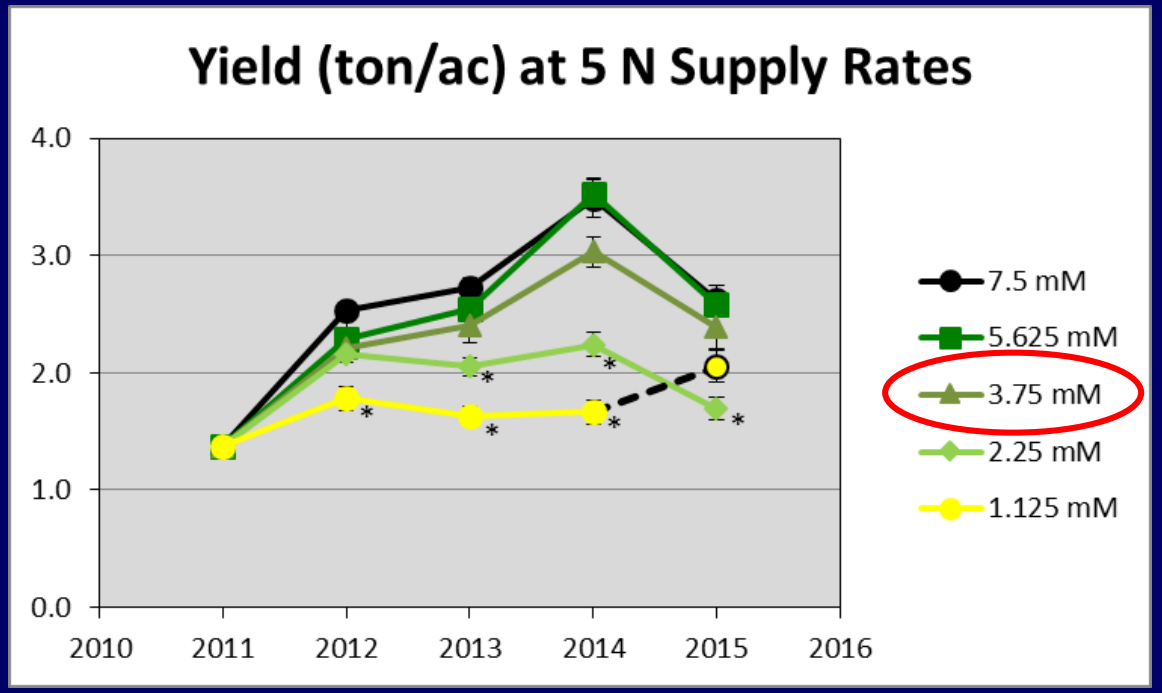
NPK 2

N Supply

Vegetative →

Reproductive →

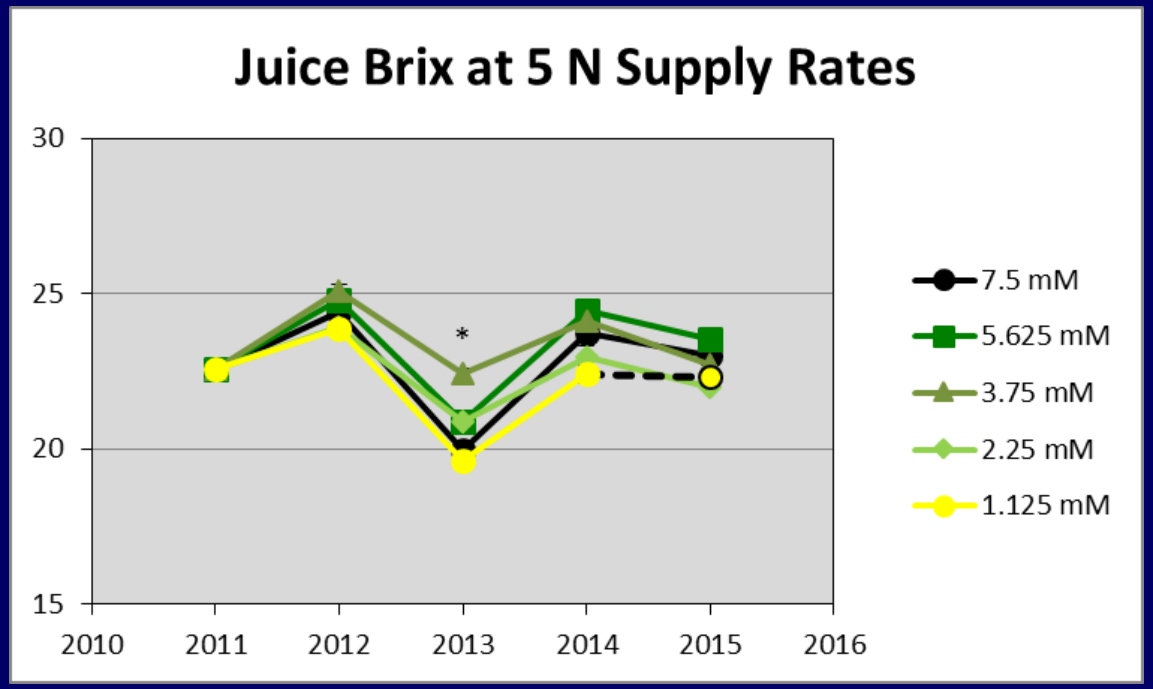


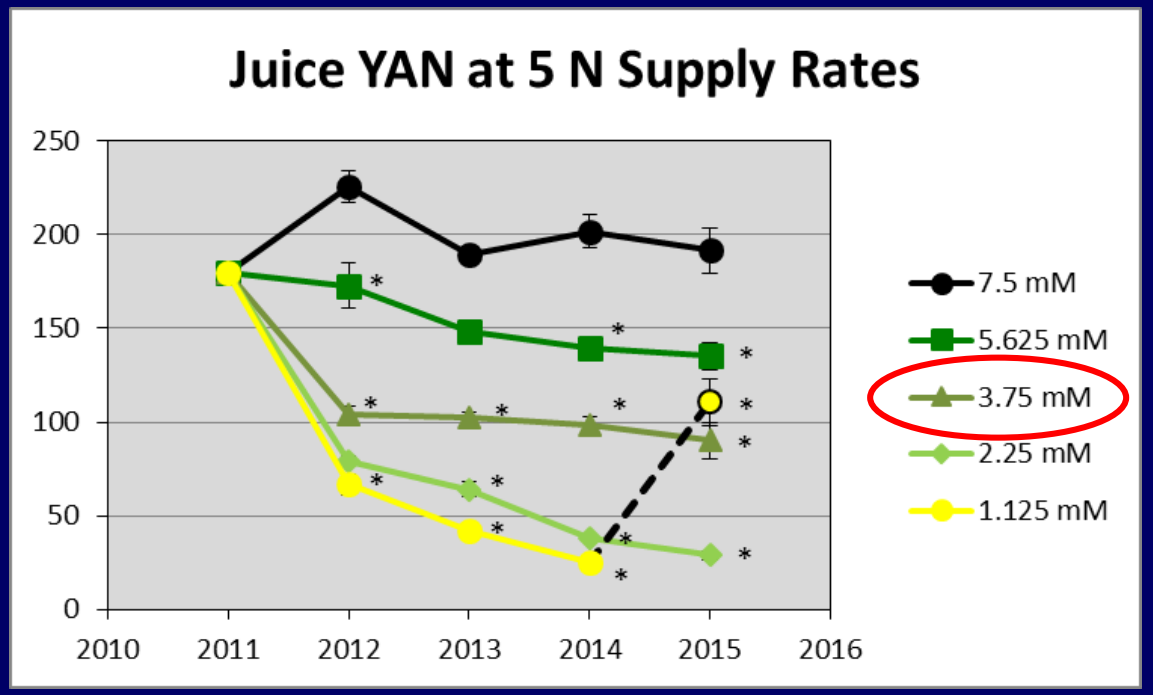


NPK 2

N Supply

Effects on Must

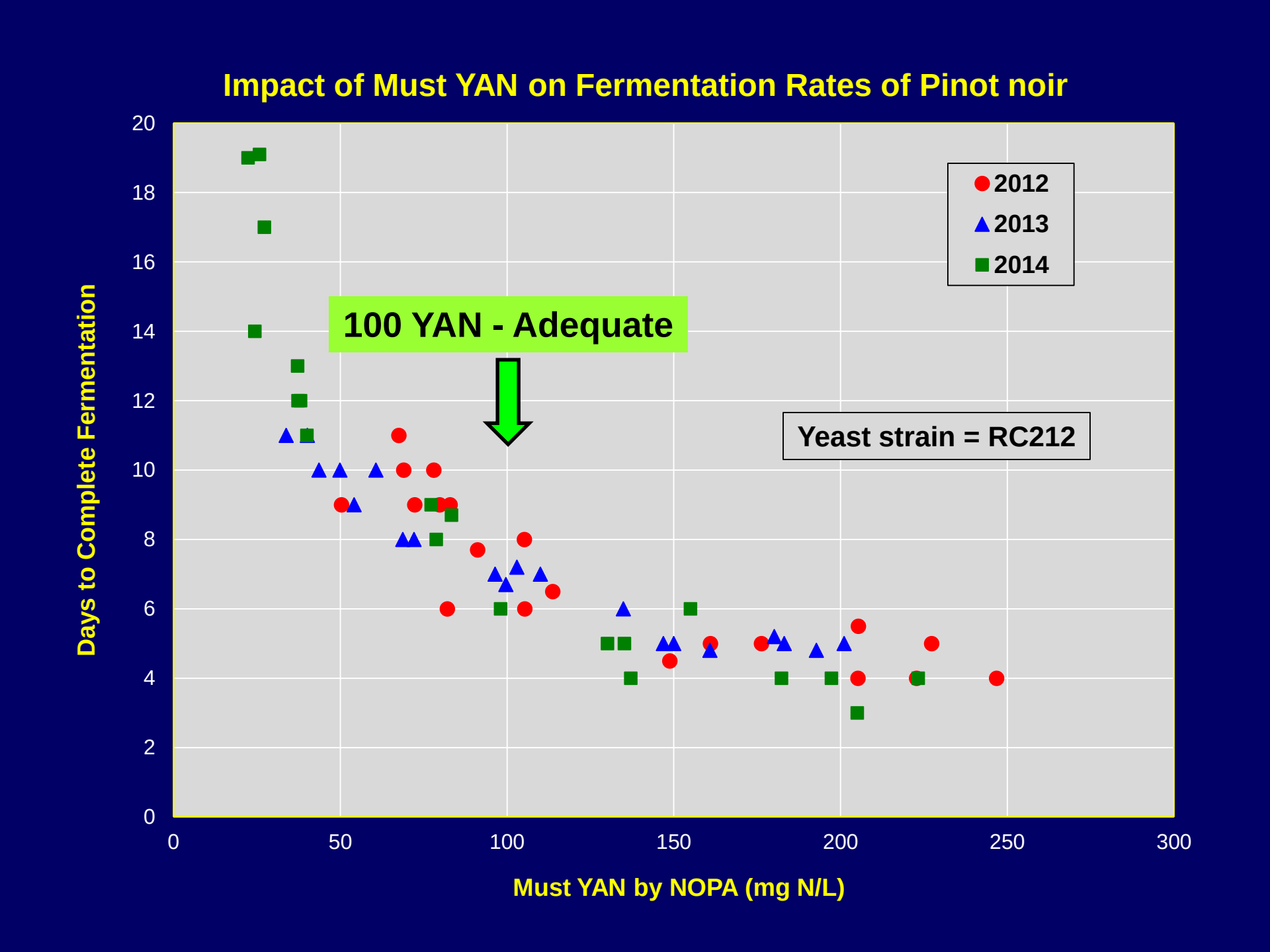




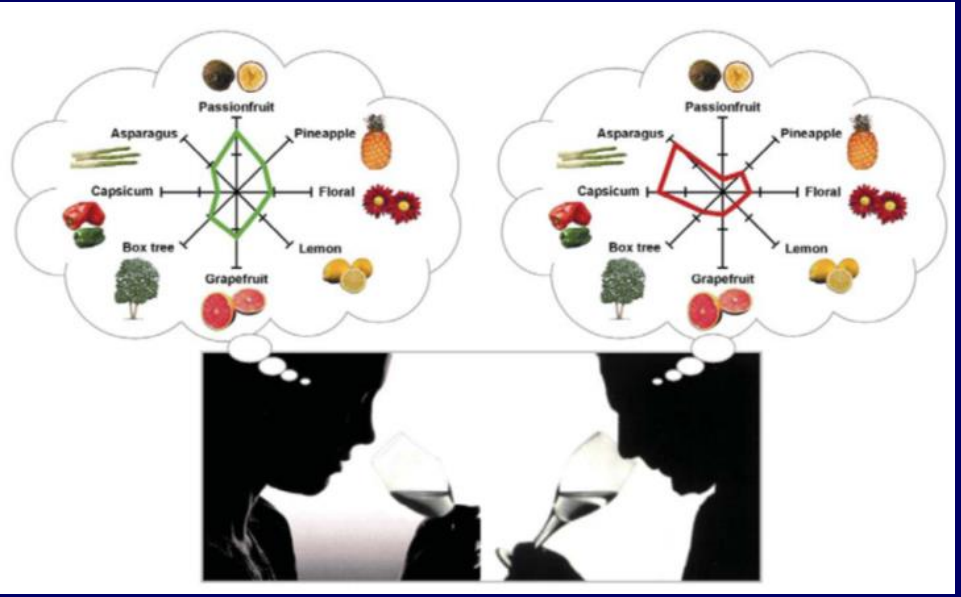
NPK 2: Fermentations 2012 - 2014

- **Each field rep separate**
- **No nutrient additions**
- **3 kg fruit**
- **Submerged cap**
- **Pressed after all reps dry**

Sampaio et al. 2007. Use of micro-scale fermentations in grape and wine research. AJEV


Impact of Must YAN on Fermentation Rates of Pinot noir
Days to Complete Fermentation
Must YAN by NOPA (mg N/L)
0
2
4
6
8
10
12
14
16
18
20
0
50
100
150
200
250
300
2012
2013
2014
100 YAN - Adequate
Yeast strain = RC212

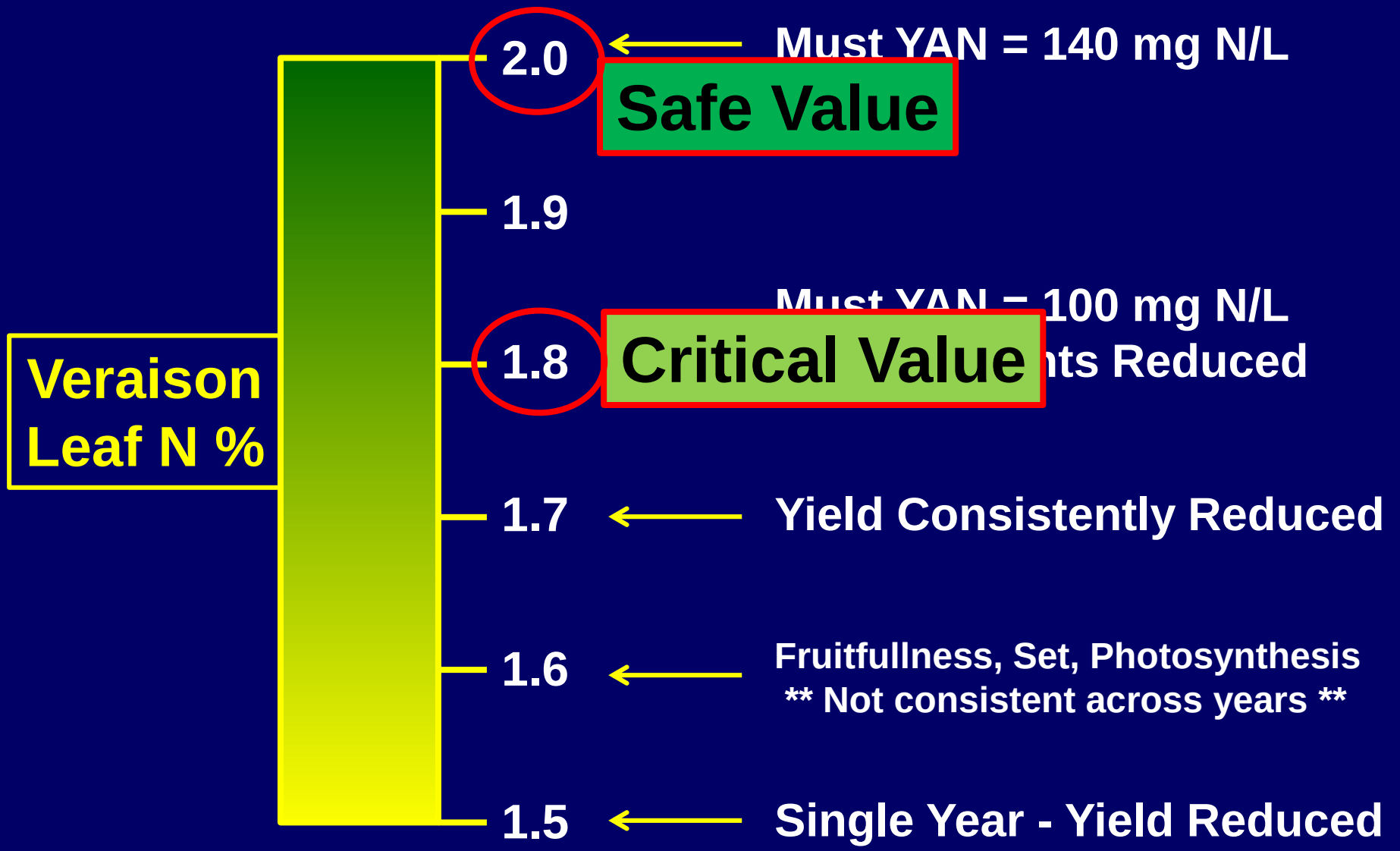
NPK 2: Effects on Wine Aroma (2012-2014)



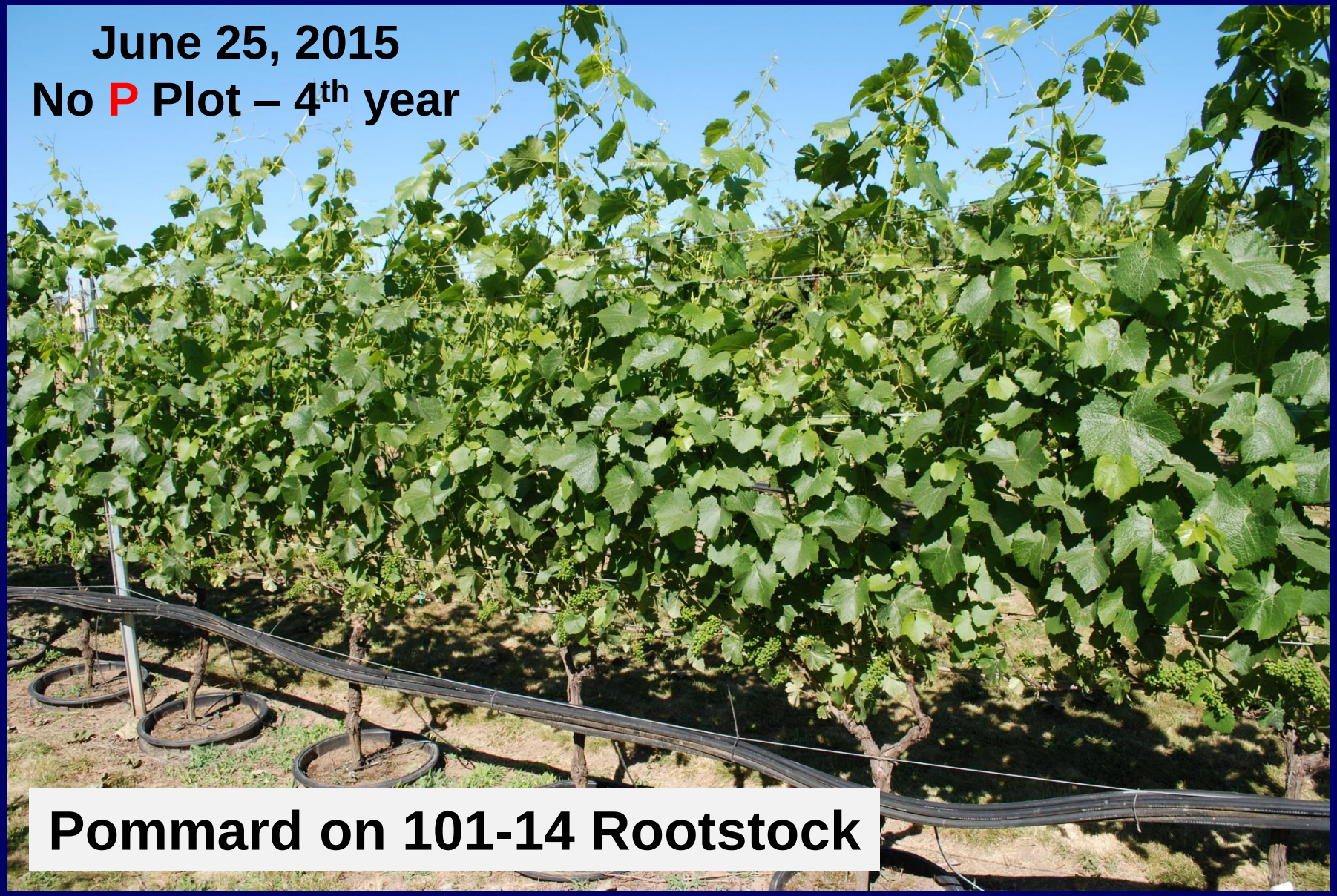
- N Supply had a huge impact on wine volatiles !
- N - altered yeast-derived volatiles by modifying branched chain : straight chain esters.
- High N musts had more bad sulfur compounds

Yuan et al. AJEV 2018

Impact of N Status on Pinot noir Performance



P findings from NPK 2



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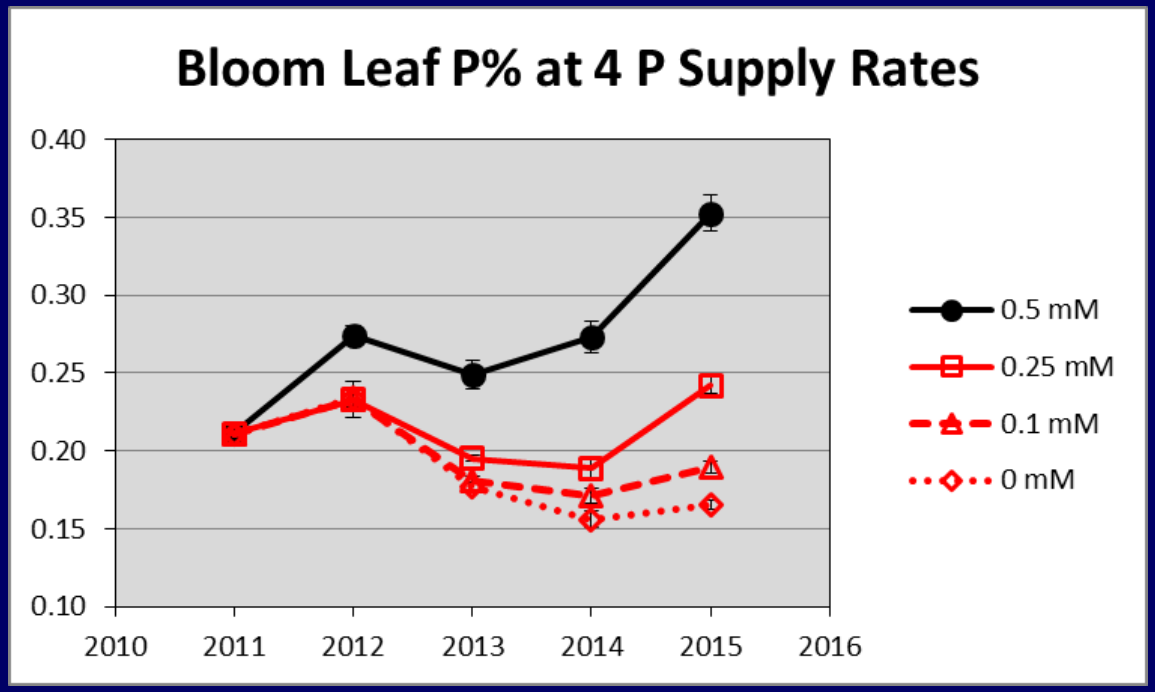

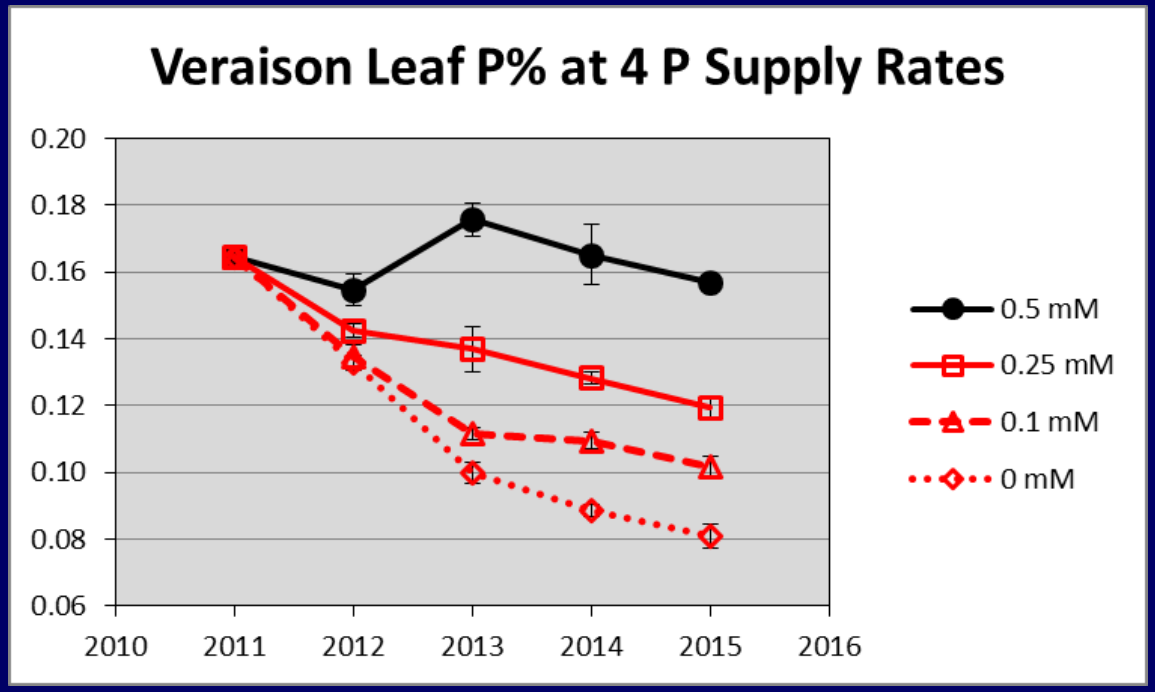

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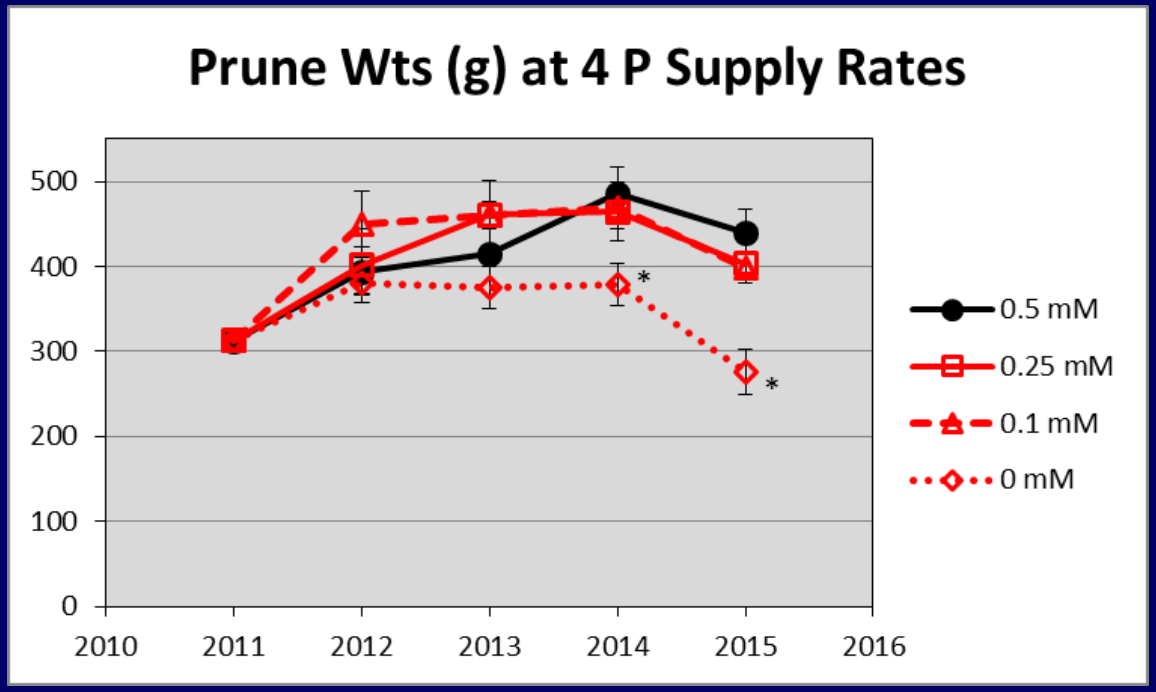
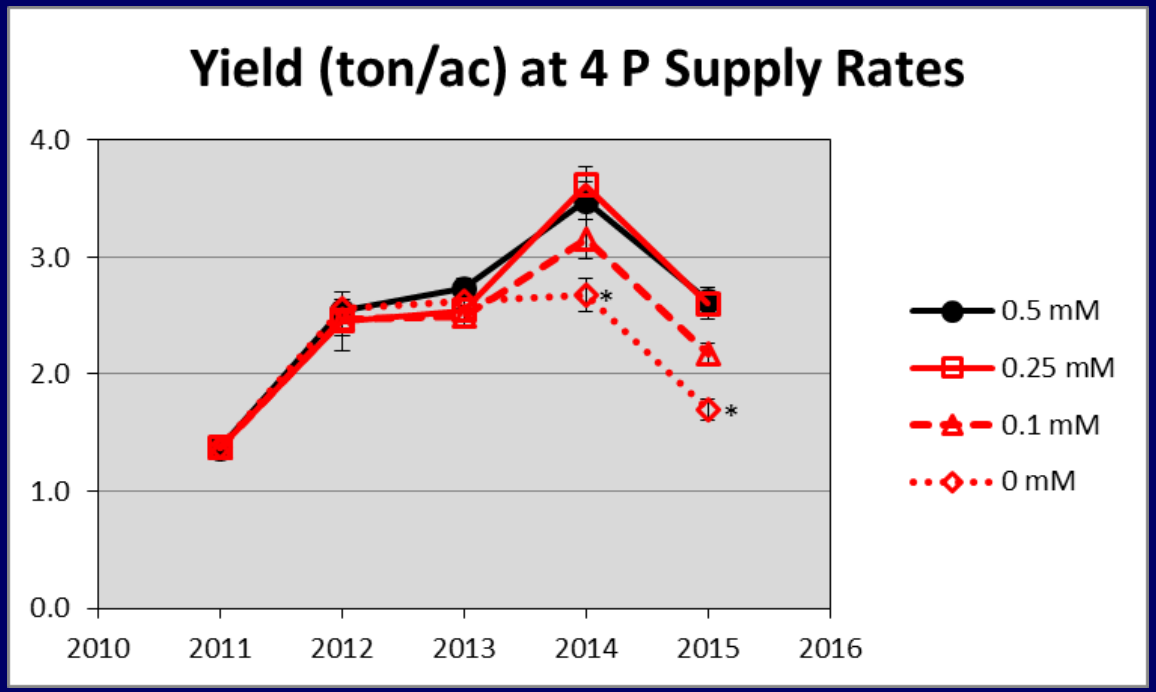
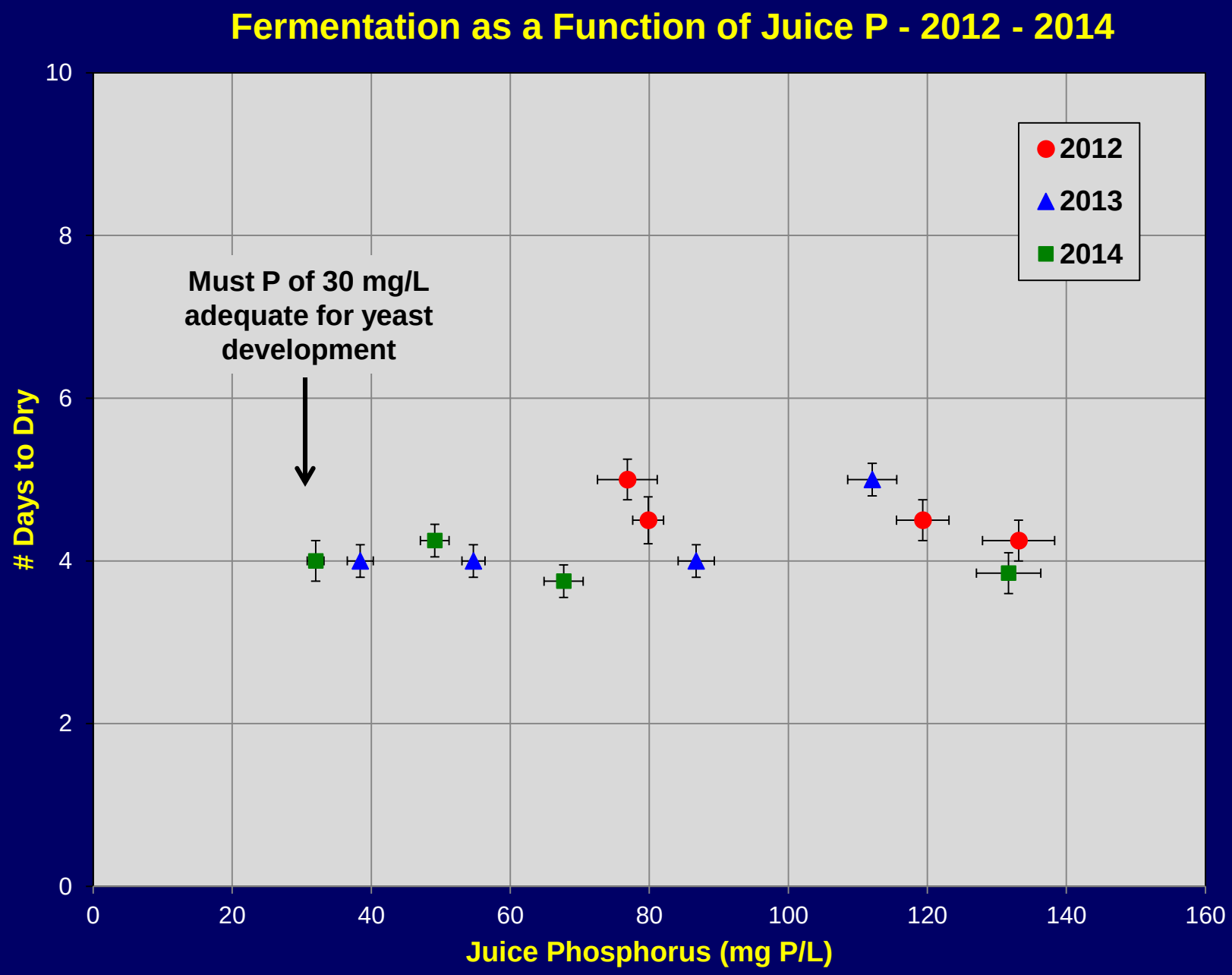
Vegetative →

Reproductive →



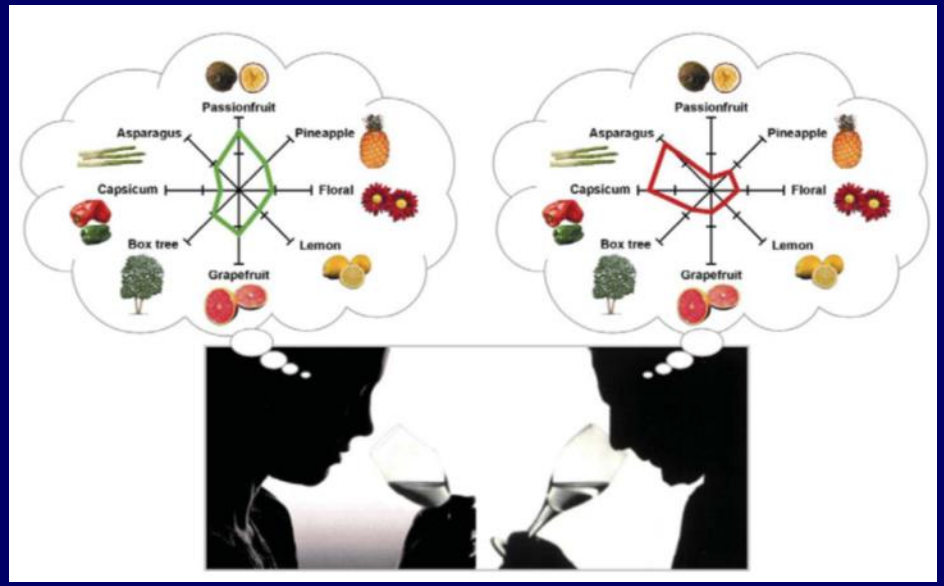



Fermentation as a Function of Juice P - 2012 - 2014
Days to Dry
Juice Phosphorus (mg P/L)
0
2
4
6
8
10
0
20
40
60
80
100
120
140
160
2012
2013
2014
Must P of 30 mg/L adequate for yeast development

Low P Impact on Wine Aroma Volatiles

Very small effects in any year

Never the same trend twice (ANOVA)



P Needs - Conclusions

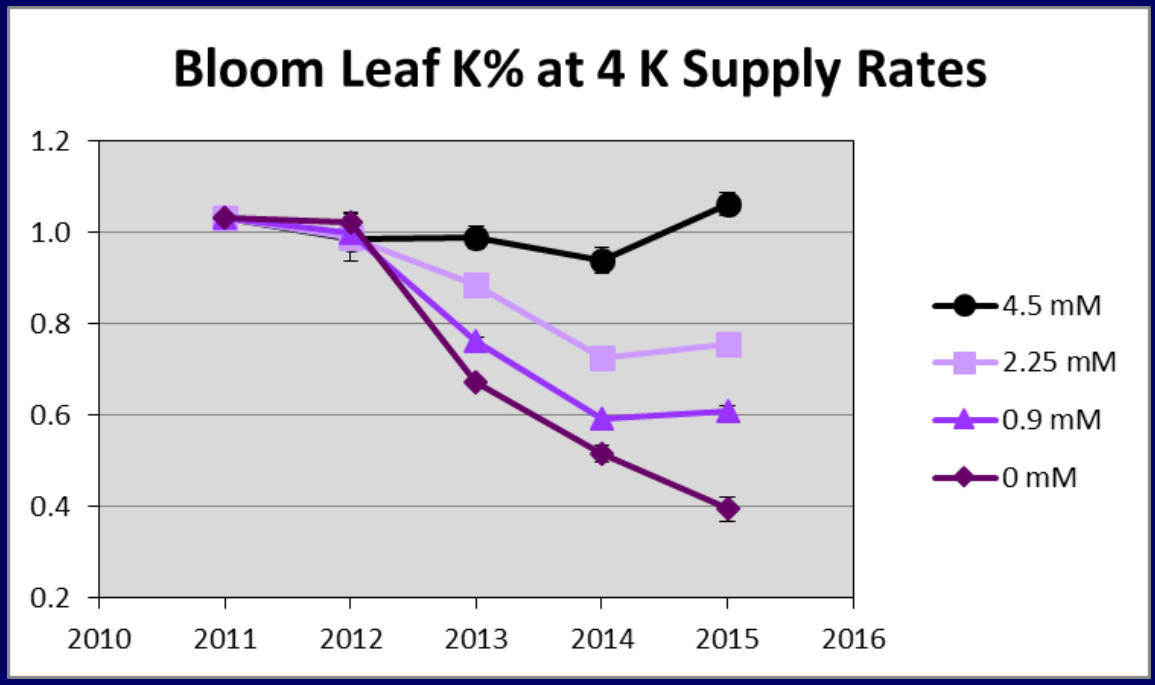
- Managing P is a viticulture issue (for Pinot noir - vegetative growth & yield were key parameters).
- No impact of P supply on flowering / fruit set / fermentation / 2° wine metabolites
- Veraison leaf blade P of 0.10% DW is critical for Pinot noir grown at typical OR yields.
- Growers should closely monitor when veraison leaf blade P is about 0.12% DW (account for sampling and lab error)

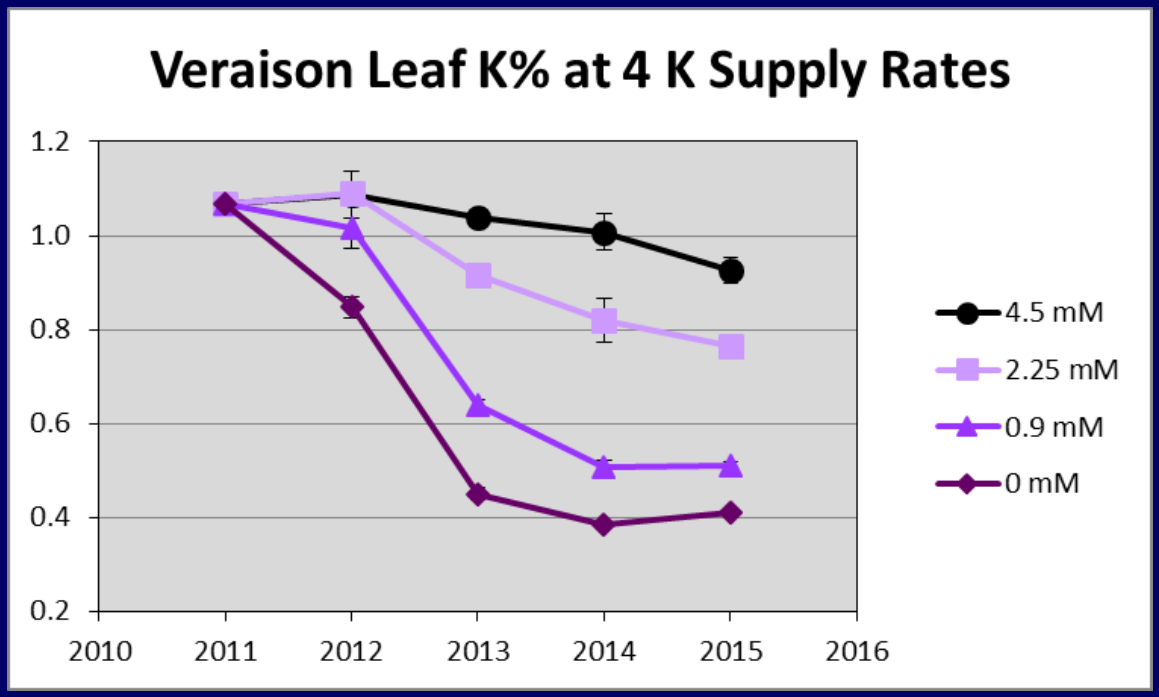
K findings from NPK 2

NPK 2

K Supply

Target Effects



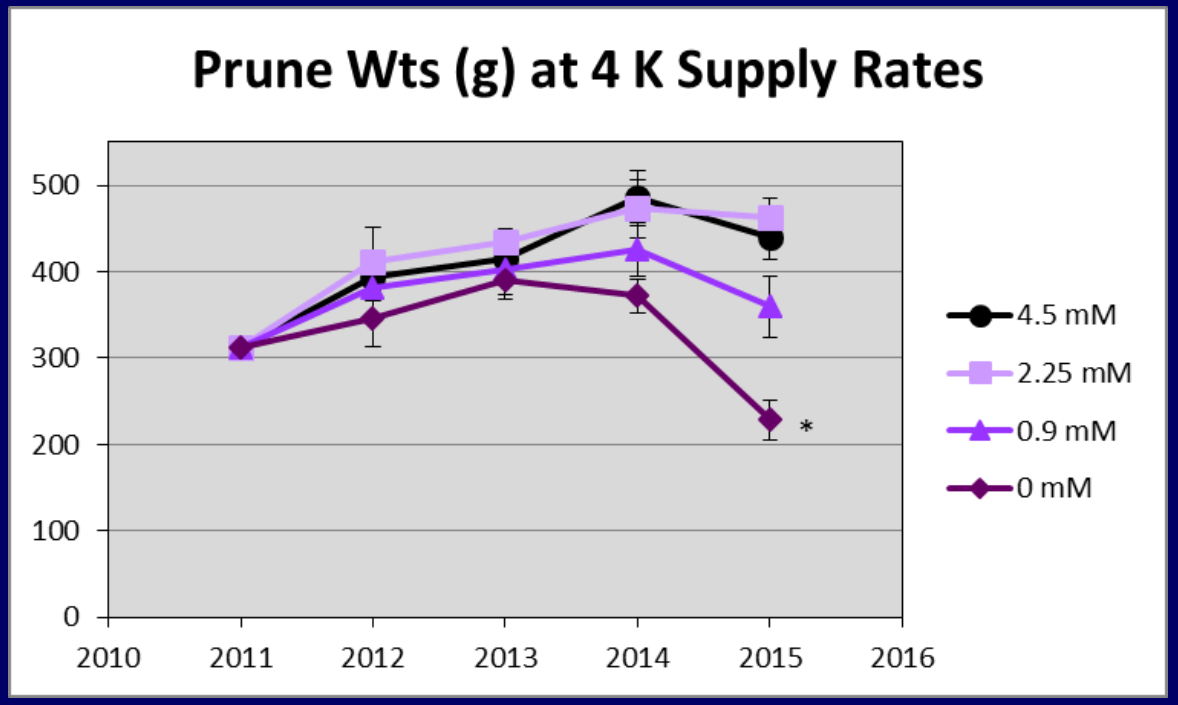


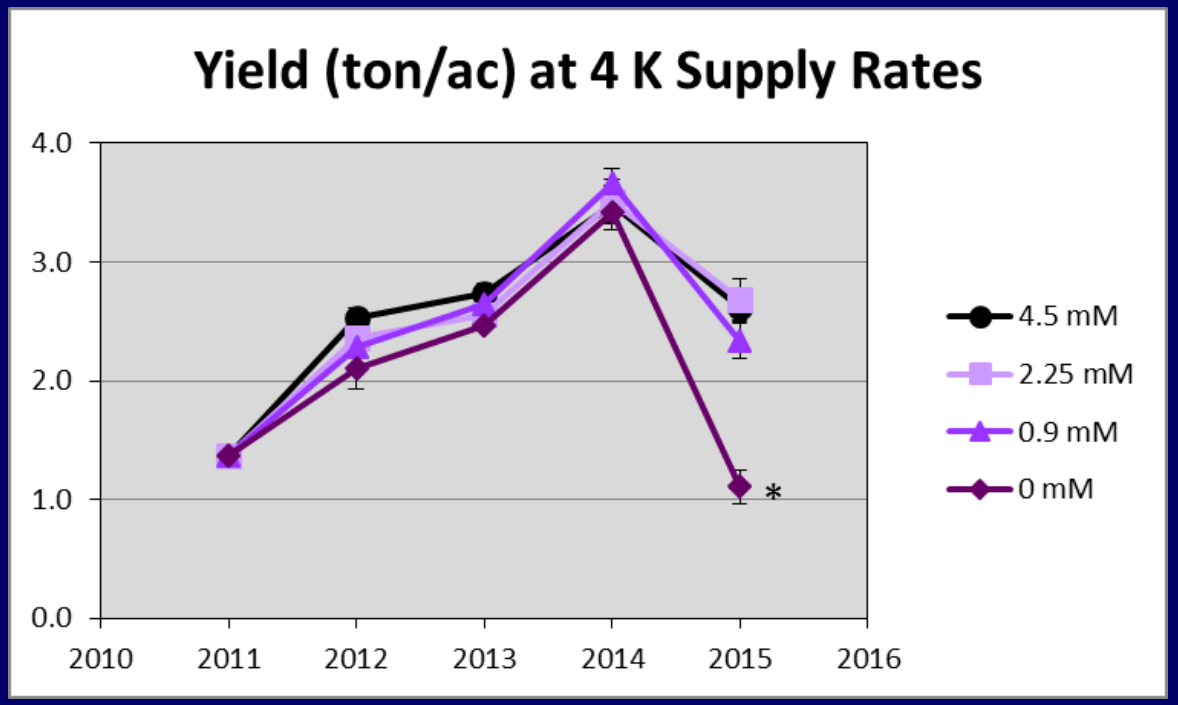
NPK 2

K Supply

Vegetative →

Reproductive →

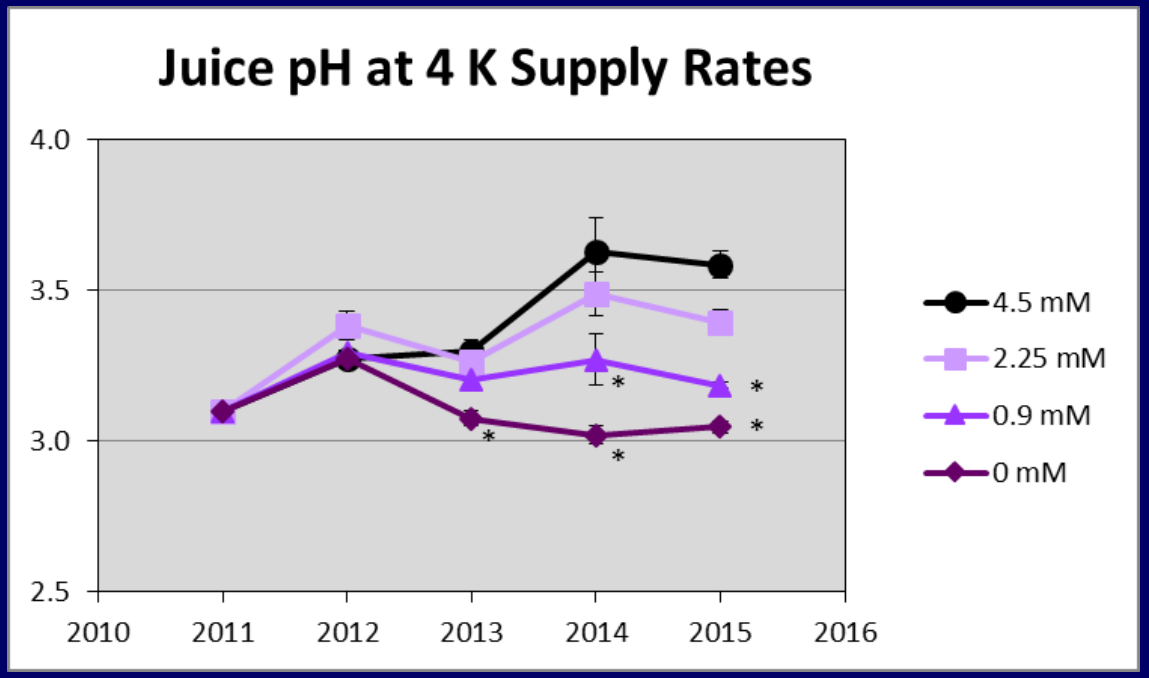




NPK 2

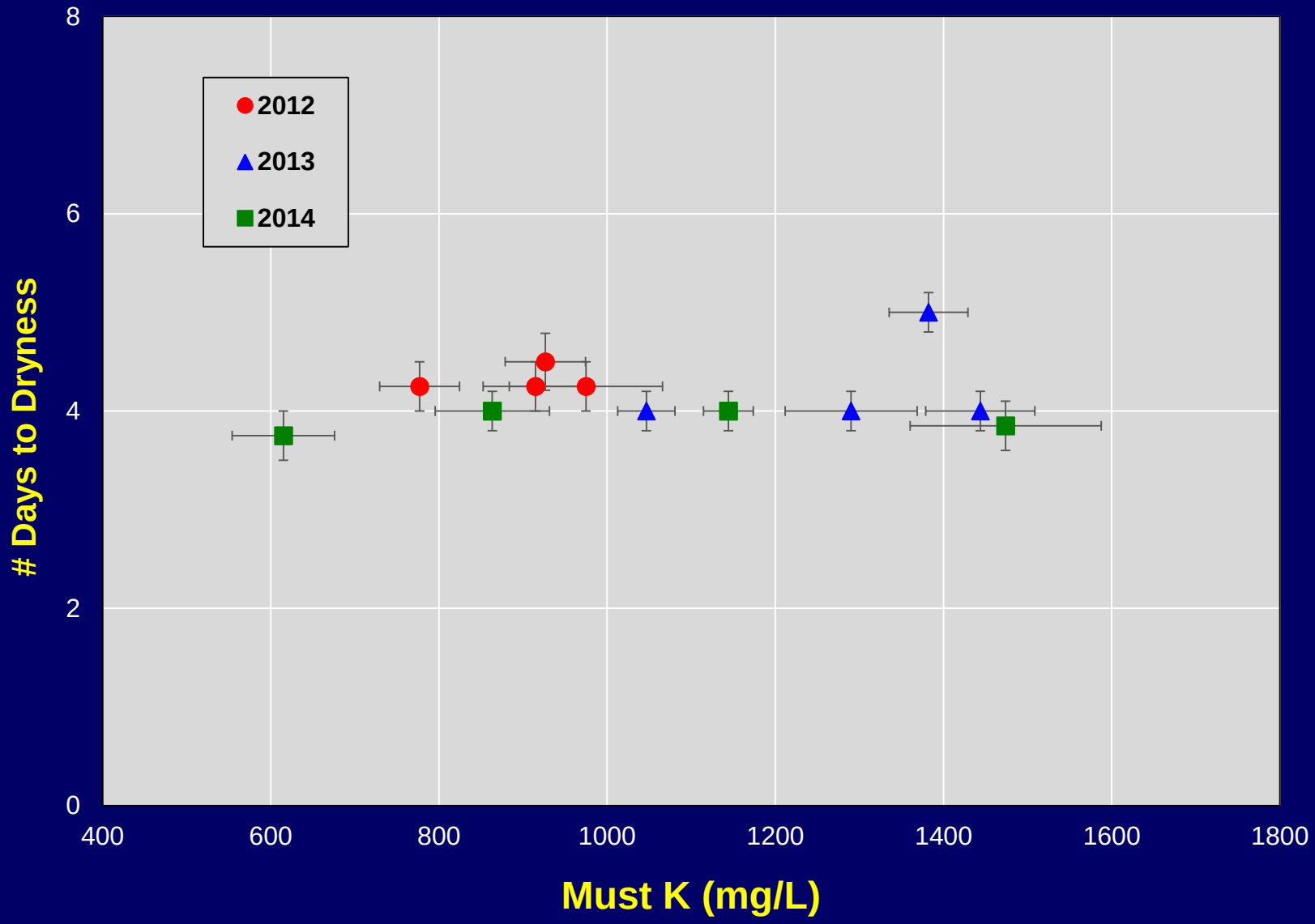
K Supply

Effects on pH in Must



July 25, 2014 – 0% K Supply – Late Stem Bunch Necrosis

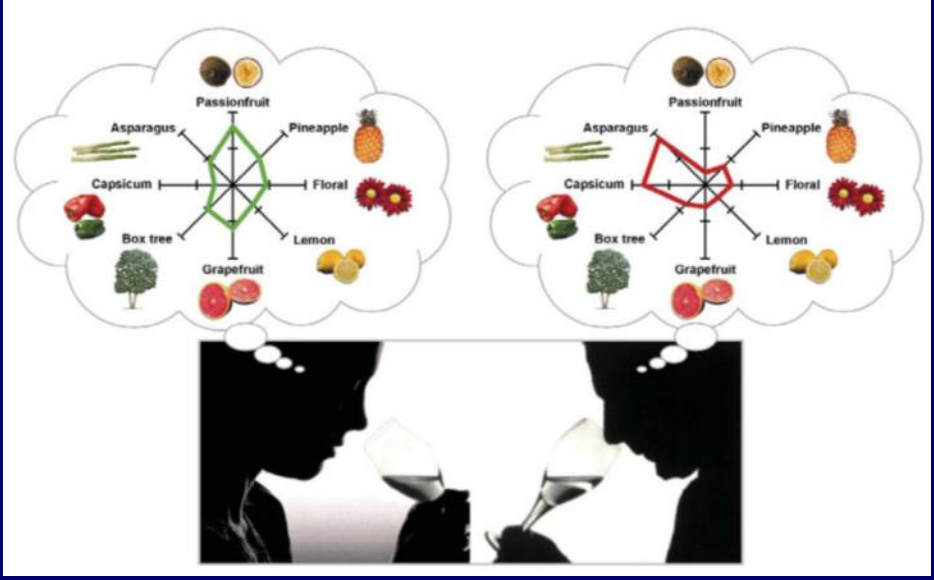
Fermentation as a Function of Must K



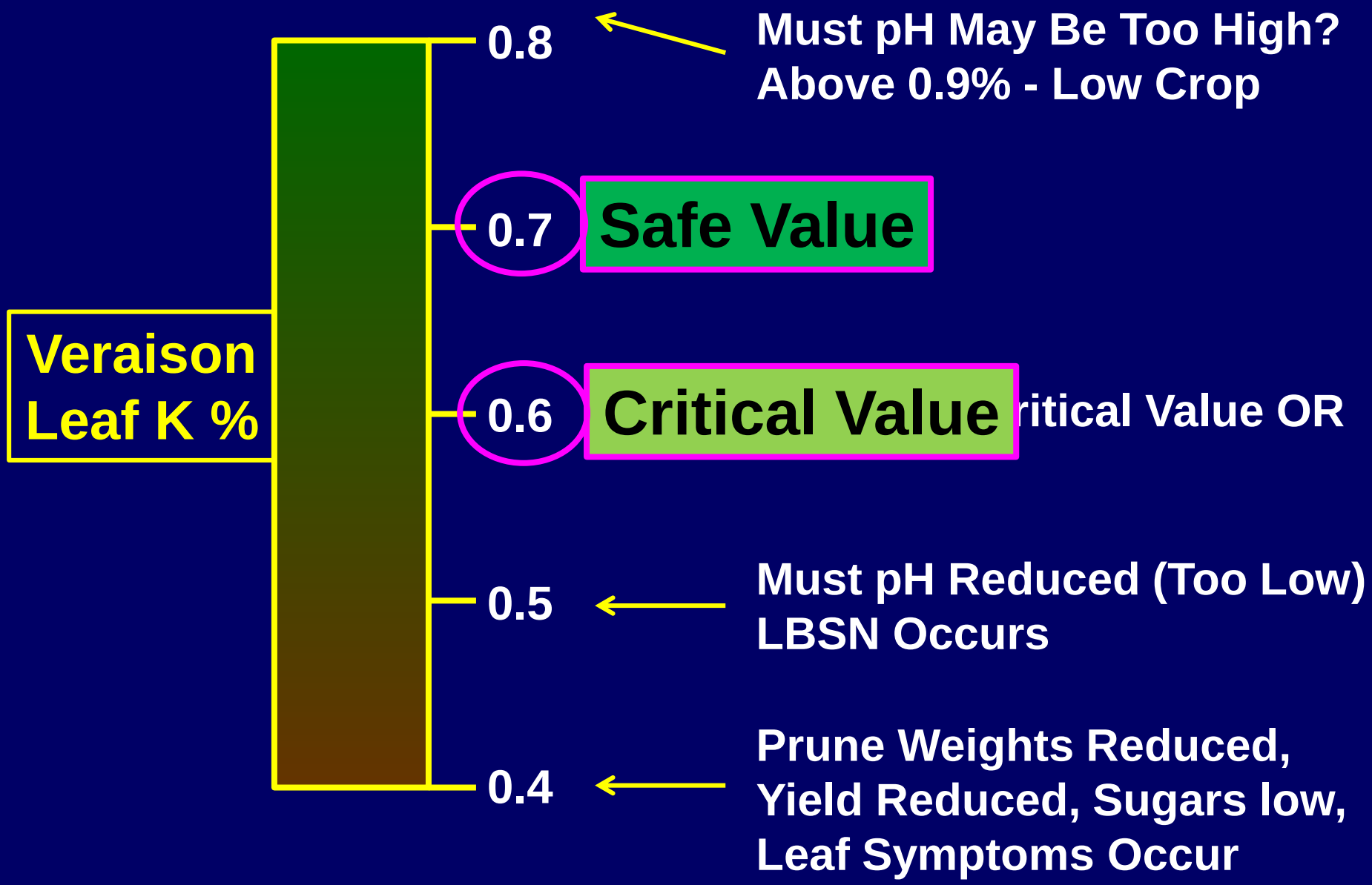
Low K Impact on Wine Aroma Volatiles

Some consistent impacts across years

Effects were small - likely not that important



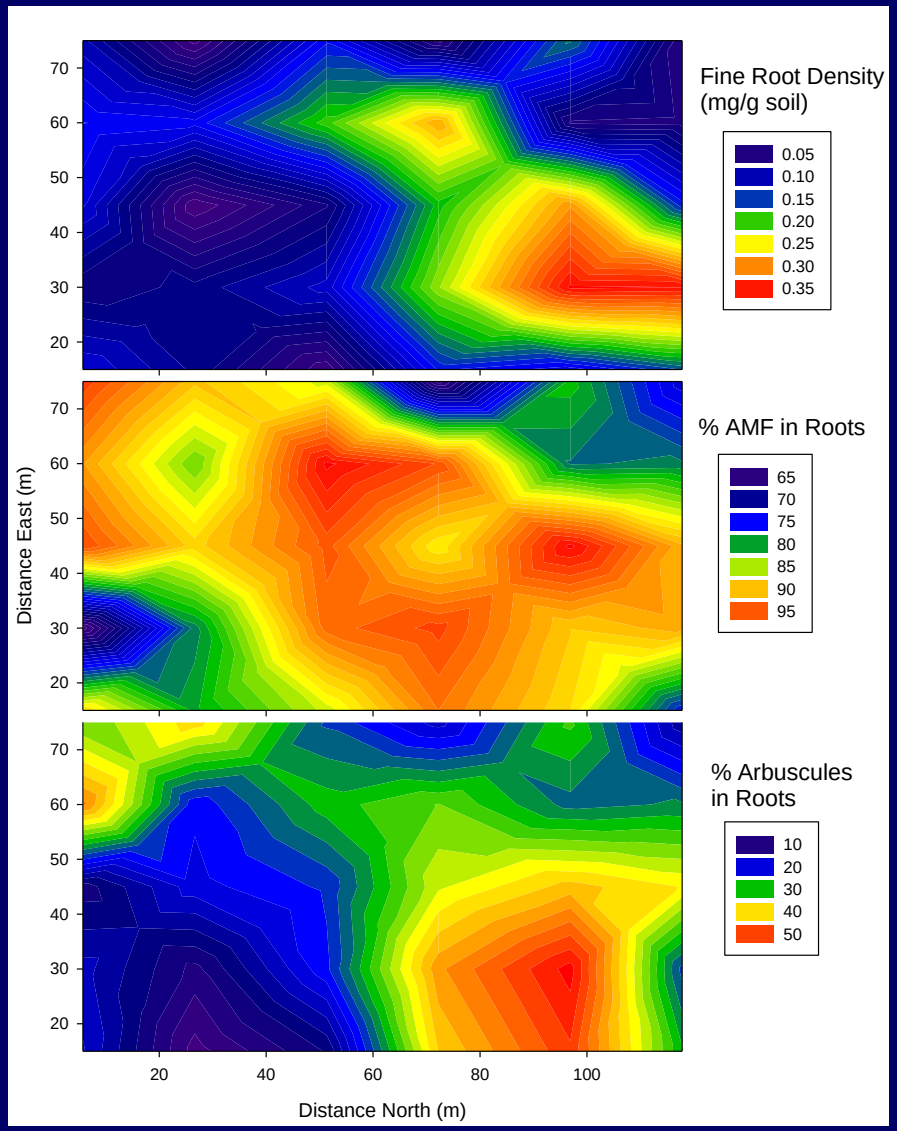
Impact of K Status on Pinot noir Performance

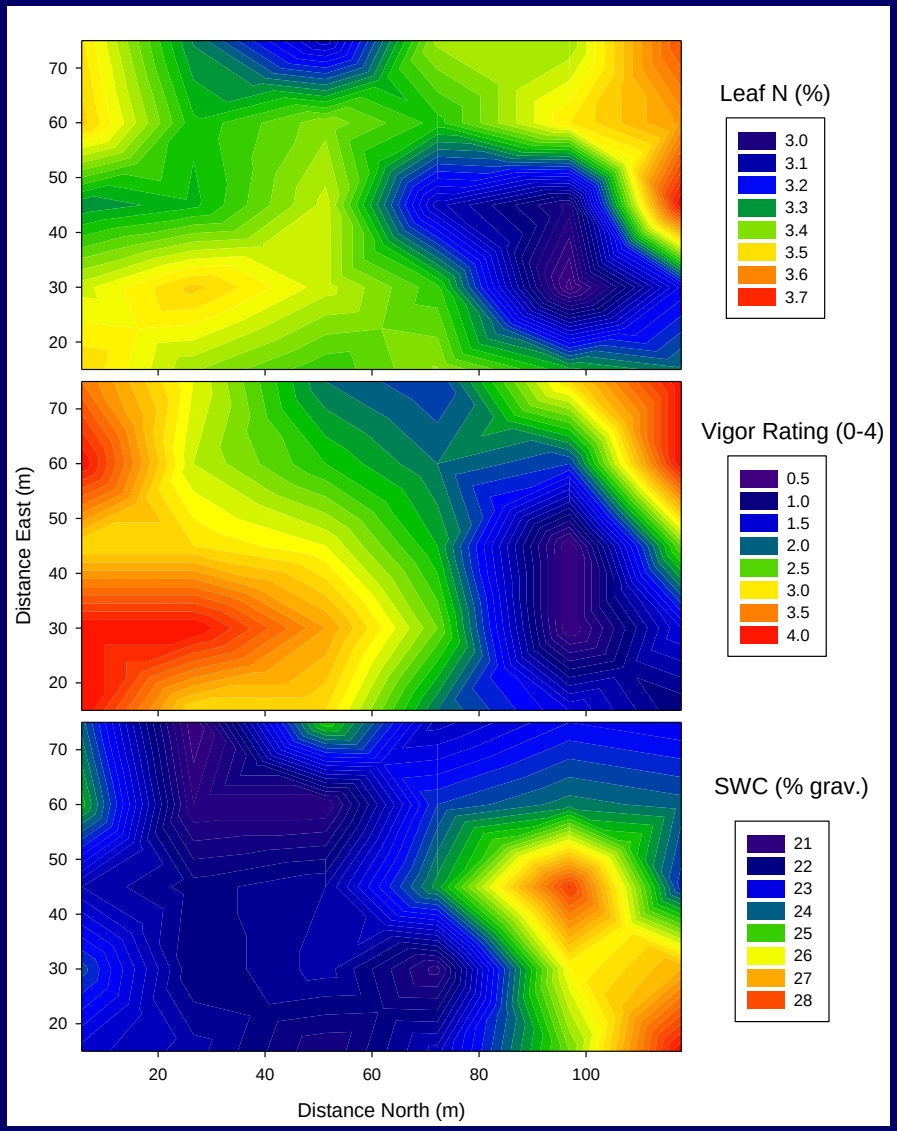


Spatial Variability of Grape Phenolics: Using Precision Viticulture Tools to Optimize Wine Phenolic Composition

J. Cortell, J. Baham, A. Connelly, A. Gallagher, M. Halbleib, J. Pinkerton, P. Schreiner, B. Watson, J. Kennedy

Spatial Analysis of Roots, AMF, and Leaf N & Vigor in a Dry-farmed Pinot Noir Vineyard 2003

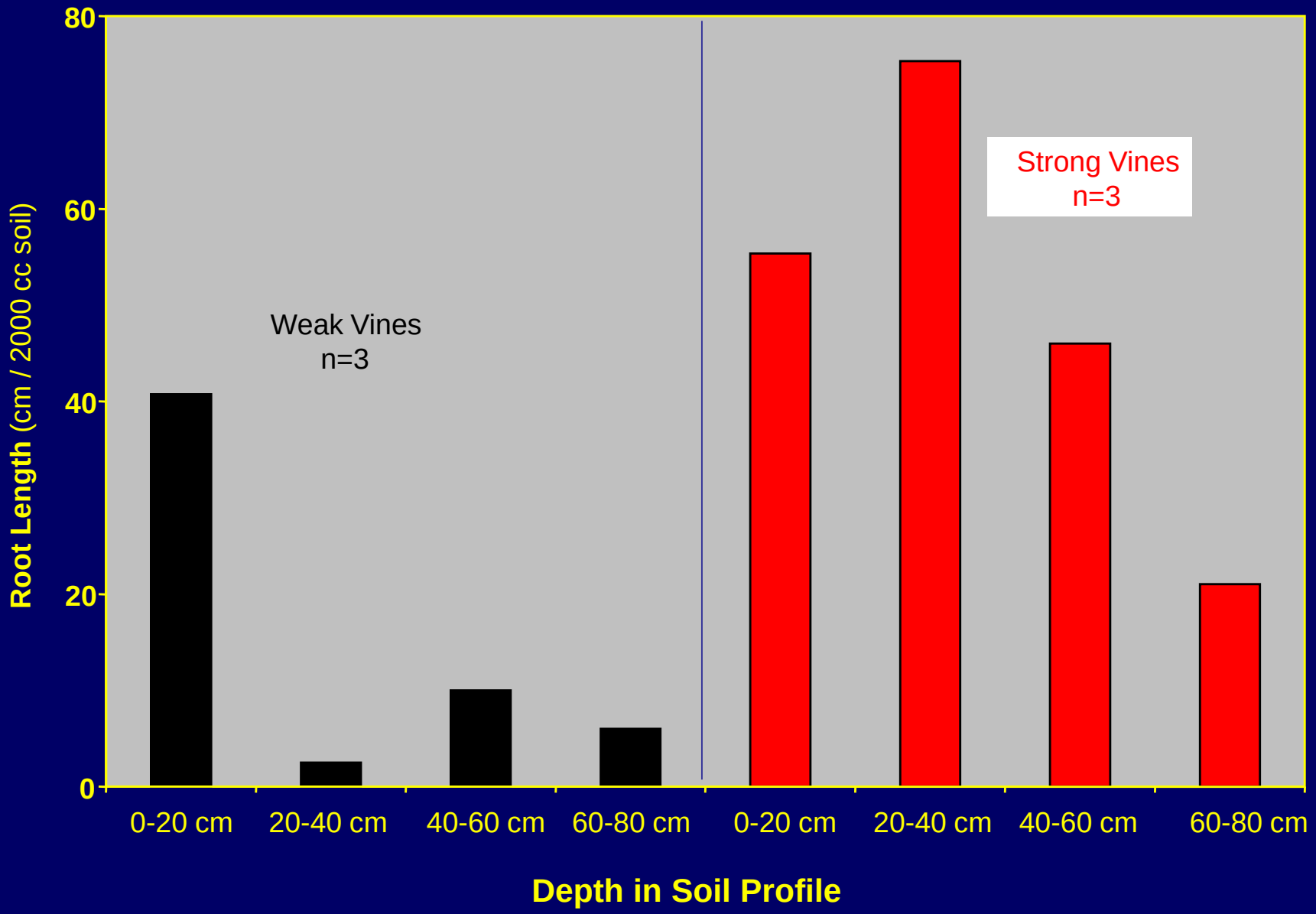




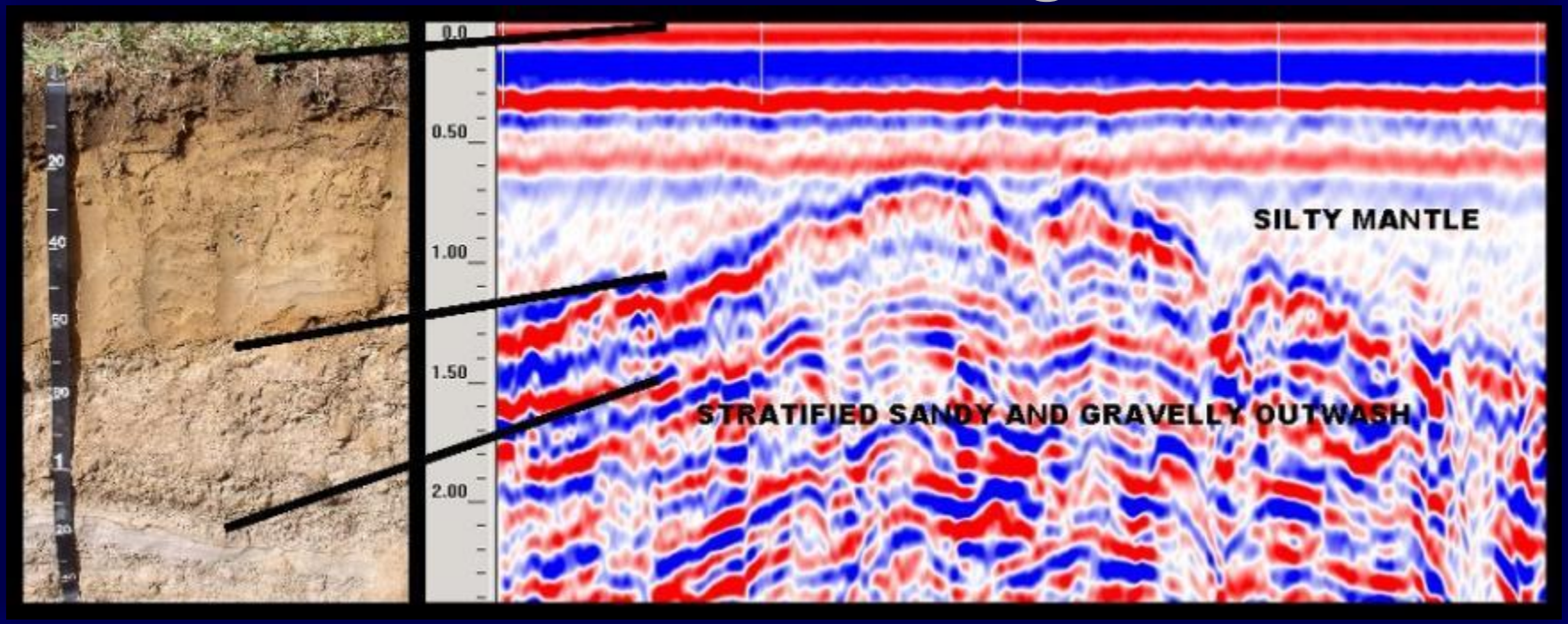
Understanding Vigor Variation
in a Valley Floor Vineyard.


Restrictive Clay Layer at Van Duzer Vineyard, 1999

Total Root Length of Vines at 4 Depths (Van Duzer Vineyard, 1999)



Ground Penetrating Radar



- Assess soil heterogeneity in pre-plant phase
- Find zones of high clay or cementation, high EC, low WHC to structure:
  - vine and row **spacing** to control vigor
  - **rootstock** selection & placement to mediate root limiting layers
  - **scion** selection & placement could address potential water stress from low WHC in soil

Photo from USDA/NRCS, Ground Penetrating Radar Program, http://nesoil.com/gpr/

Robust Levels for N Status are Difficult

- N varies between cultivars, rootstocks, soils, environments.
- N will not affect the same vine parameters across all cultivars & environments.
- N impacts fruit quality directly (amino N & YAN) and indirectly (shading / water stress impact on 2° metabolites).
- N influences yeast-derived compounds during fermentation & yeast strains have variable N needs.

Wine Color in 2014

N Supply	100%	75%	50%	30%	15%
Yield (ton/ac)	3.5	3.5	3.0	2.2*	1.7*

NPK 2

P Supply

Effect on Growth & Yield

Occurs when Leaf P < 0.10%