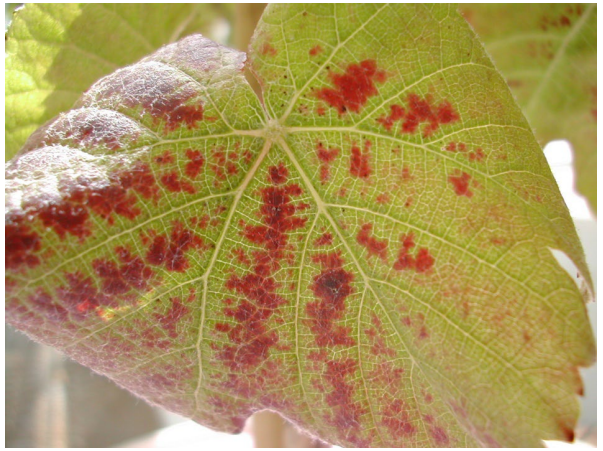
The Value of Tissue Nutrient Tests for Viticulture

R. Paul Schreiner, USDA-ARS, Corvallis OR

2023 Oregon Wine Symposium


Are Soil Nutrient Tests a Good Predictor of Grapevine Nutrients?

Nutrient	Soil Test Values (ppm)	Leaf Test Values (% or ppm)	Correlation Coefficient (r)
N	4.0 - 26	2.5 - 4.3	*** 0.360 ***
P	8 - 6	0.33 - 0.52	0.138
K	14 - 4	3	0.270
Ca	260 - 3	0	0.323
Mg	49 - 1	5	0.228
Fe	9 - 1		-0.159
Mn	5 - 6		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

Short Answer

NO

29 own-rooted Pinot noir & Chardonnay Blocks - Schreiner & Linderman 2005

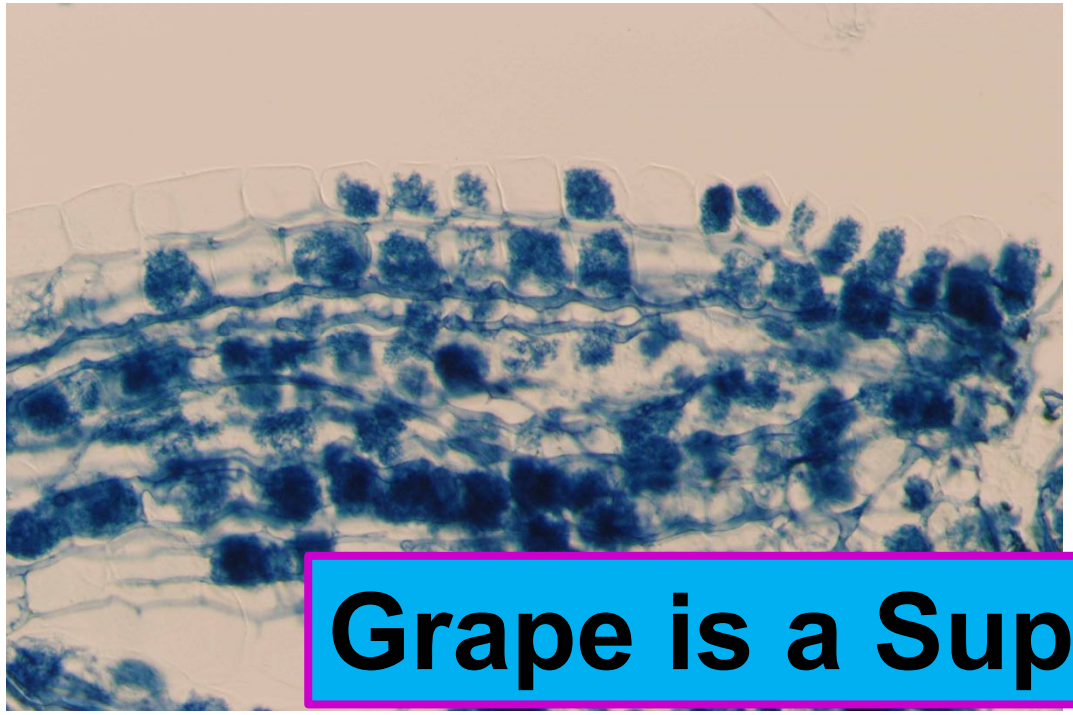
Tissue Analysis
Why is this better than Soil?

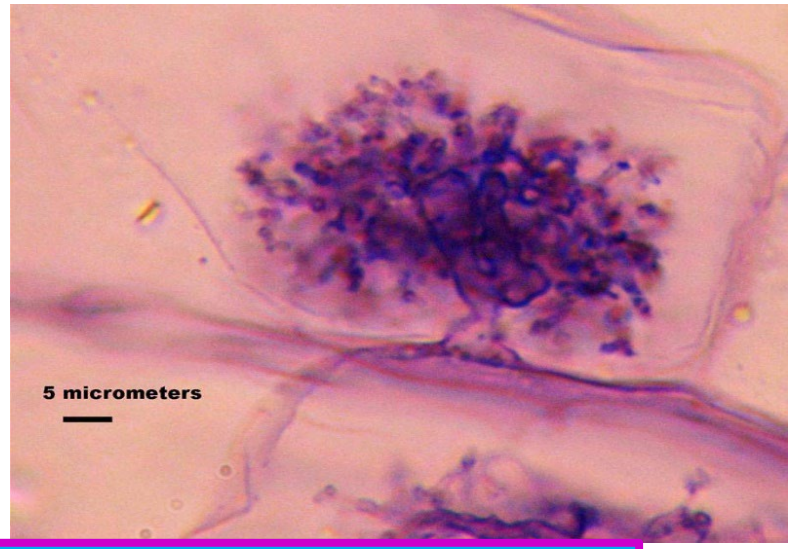
"Soil analyses usually have not proved reliable….
due in part to difficulties in getting soil samples truly representative of the root distribution and to the difficulty in establishing laboratory techniques to extract elements from samples to the same degree in a few minutes that the grapevine does over a period of up to six months activity"

Cook 1966 ('Grape Nutrition' book chapter)

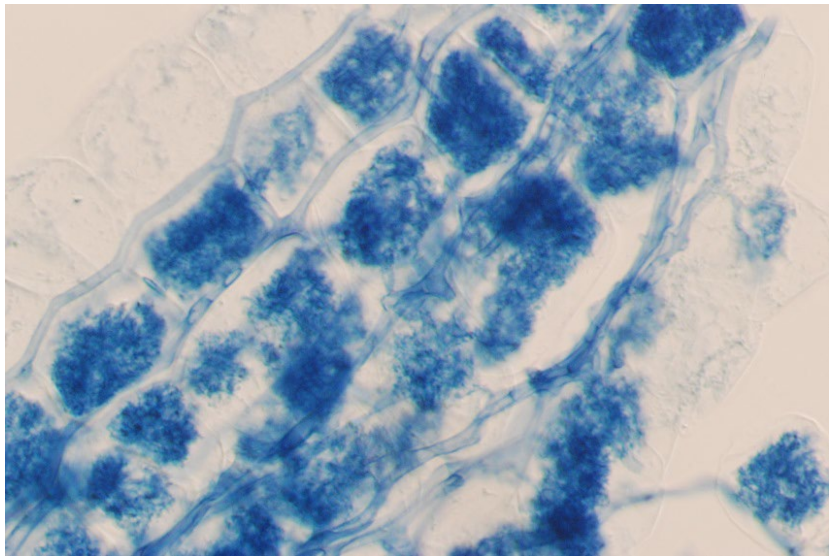
I was 3 years old when Cook wrote this, and we are still largely in same boat !!

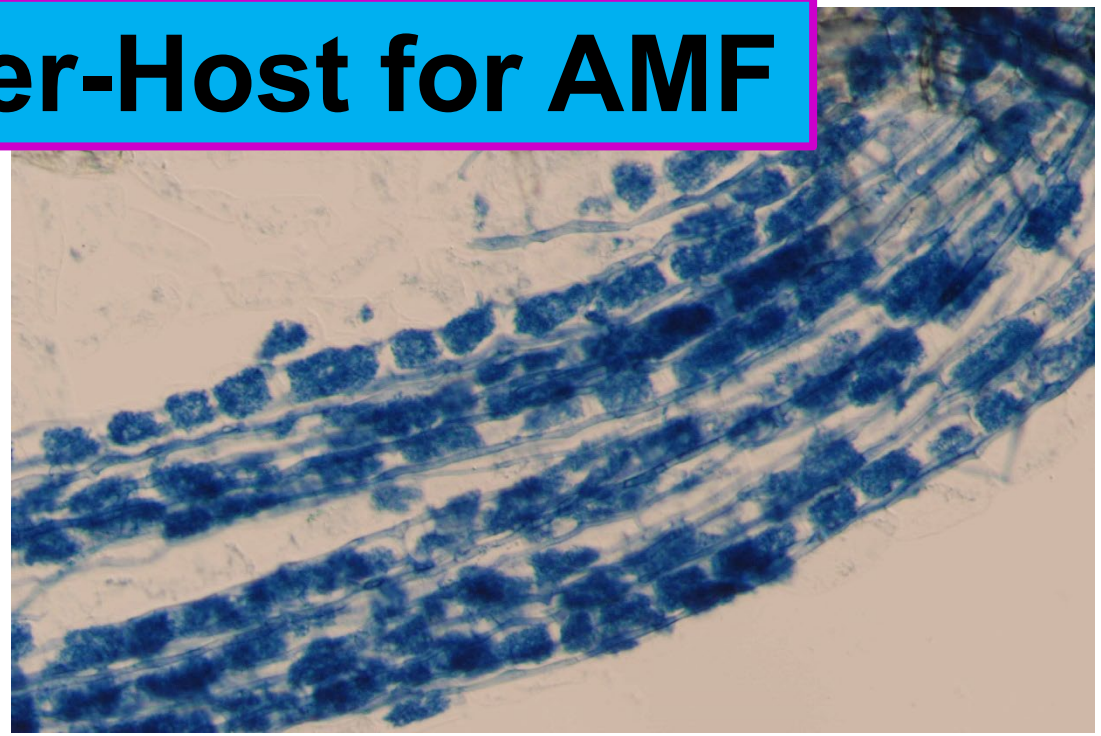
Very Low soil P in our Red Hill Soils - Not a PROBLEM due to AMF ☺





Grape is a Super-Host for AMF





Outline for Today's Talk

- Brief History / Sample Collection Issues
- Leaf blade vs Petiole – debate rages ☺
- Dormant Wood – any Good?
- Critical / Optimal Values
- Conclusions

Brief History - Nutrient Tissue Tests in Vineyards

- **French were first (1920's) – whole leaf blade to diagnose adequate NPK, 4 times/season**
- **Leaf blades have been 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 (leaf blades are the metabolic work-horse of the canopy).**

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

Collecting Leaf Blades/Petioles for Routine Nutrient Analysis

For Veraison, I recommend sampling <u>both</u> a recently fully expanded leaf and a basal leaf in pairs & combine.

Bloom

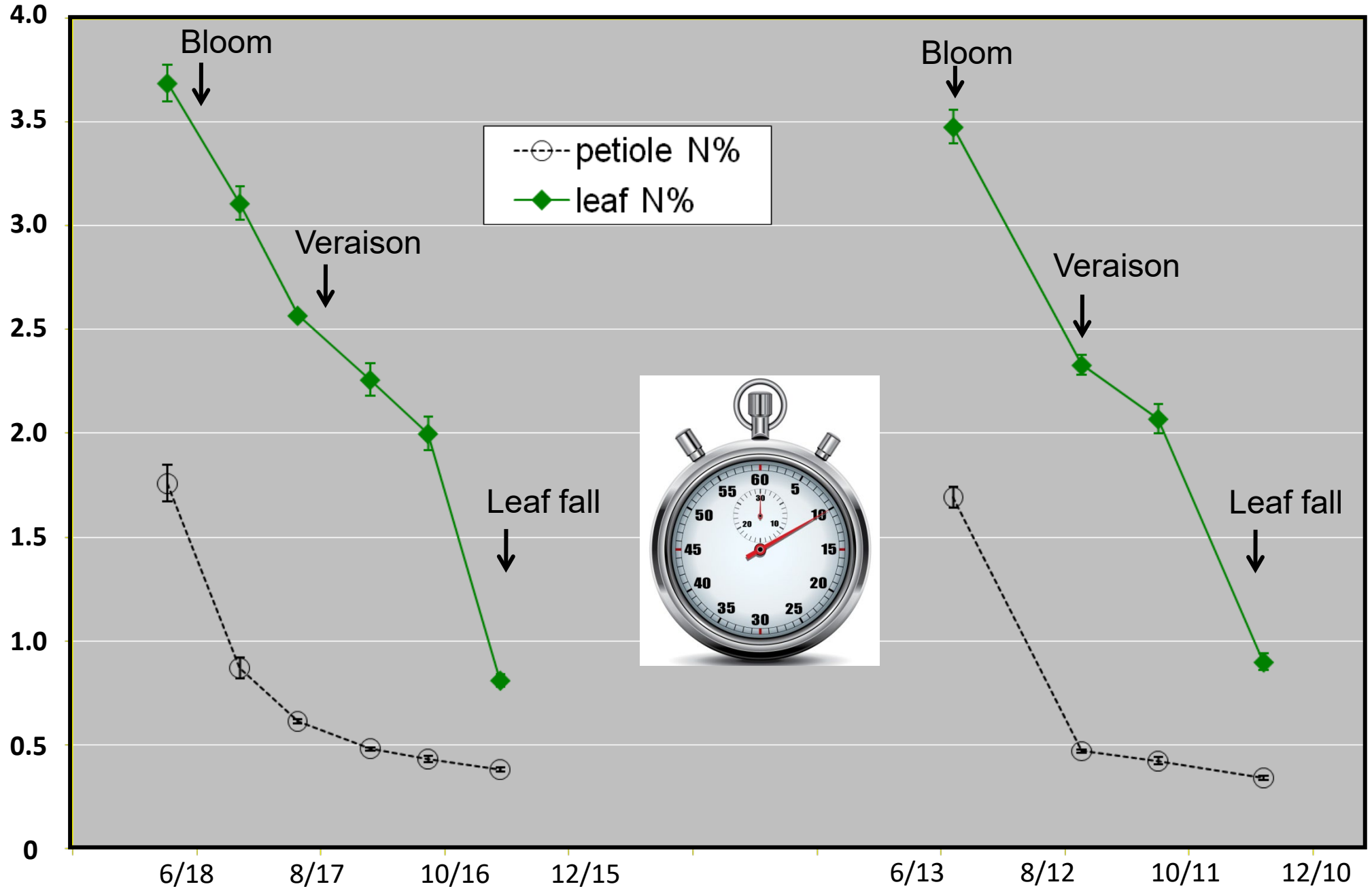
Veraison

Combining Basal & Upper Leaves - Best in Pinot noir

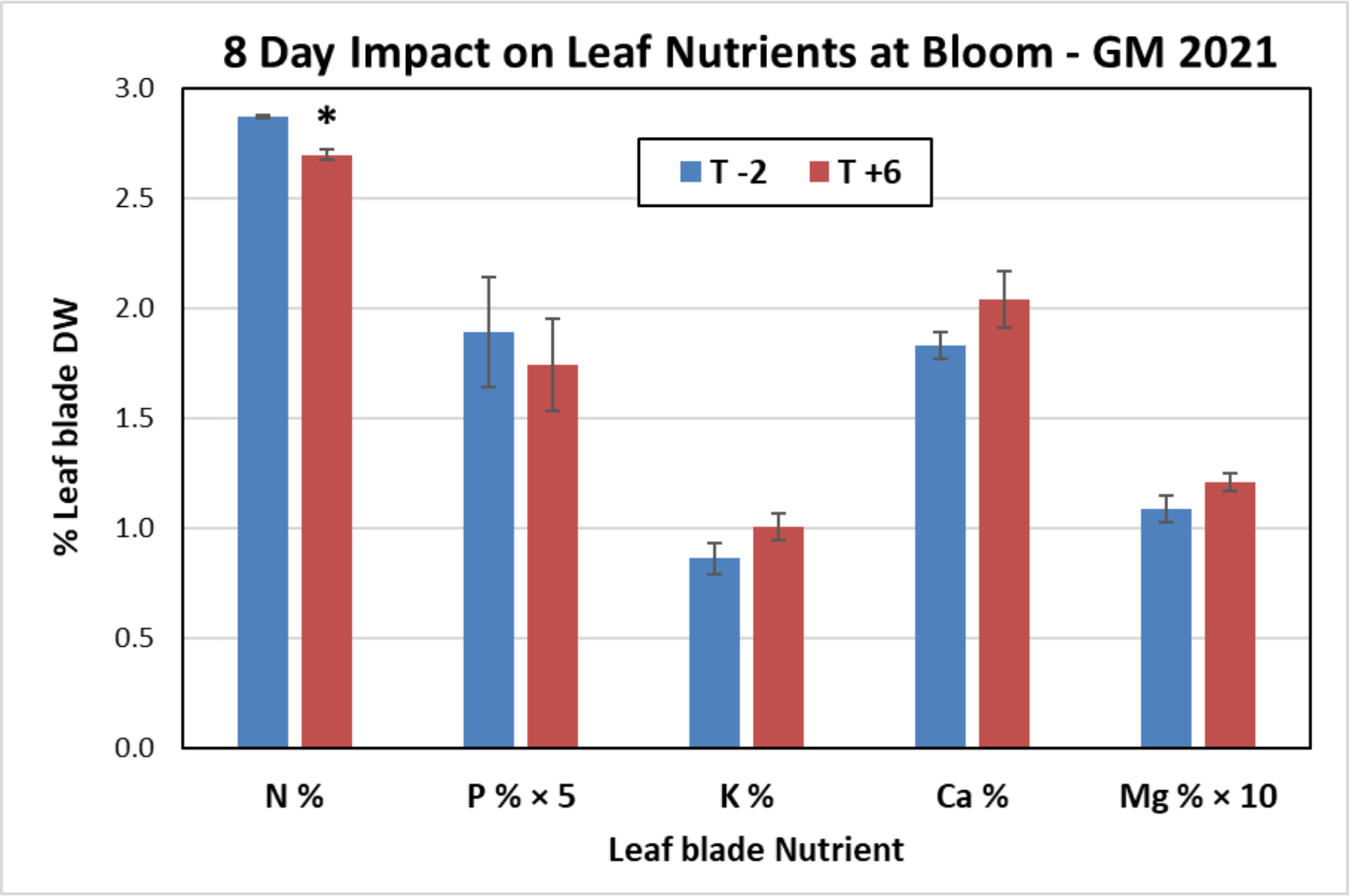
	R^2 for Predicting Different Vine Responses		
Vine Response	**Basal Leaf N (%)**	**Upper Leaf N (%)**	**Combined Leaf N (%)**
Must YAN	0.666	0.625	**0.738 ***
Prune Wts	0.667	0.685	**0.735 ***
Leaf Area	0.622	0.611	**0.688 ***
Yield	0.582	**0.640 ***	0.638

Schreiner, unpublished

Changes in Leaf blade and Petiole N over Two Seasons – Woodhall C block



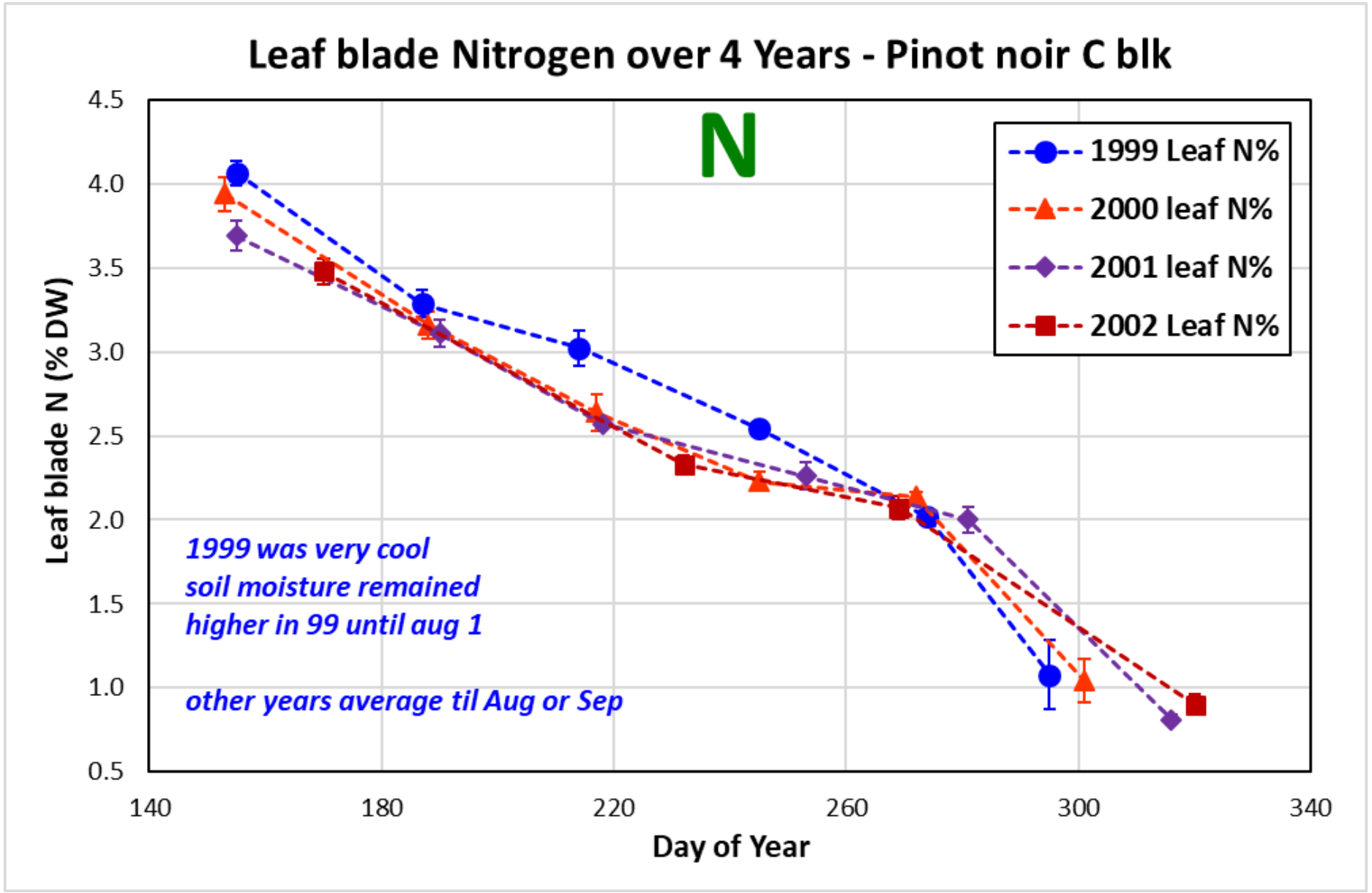
Even 8 days Alters Leaf <u>Nitrogen</u> near Bloom!



Petiole N Also sig. *

Kalauni & Schreiner, unpublished

Consistent Time of Sample Collection = Critical



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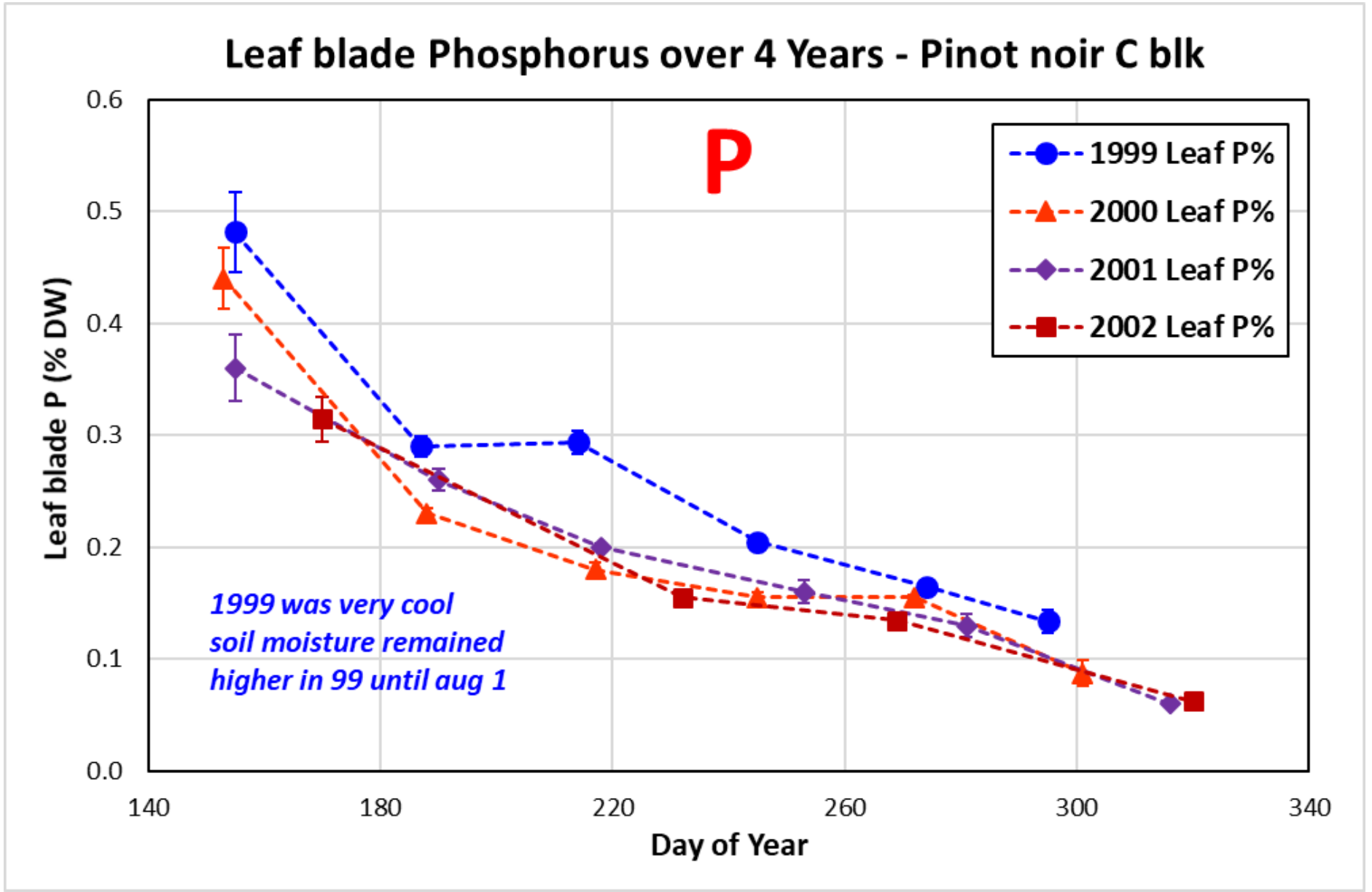


Comparing Leaf blades to Petioles for diagnosing NPK status

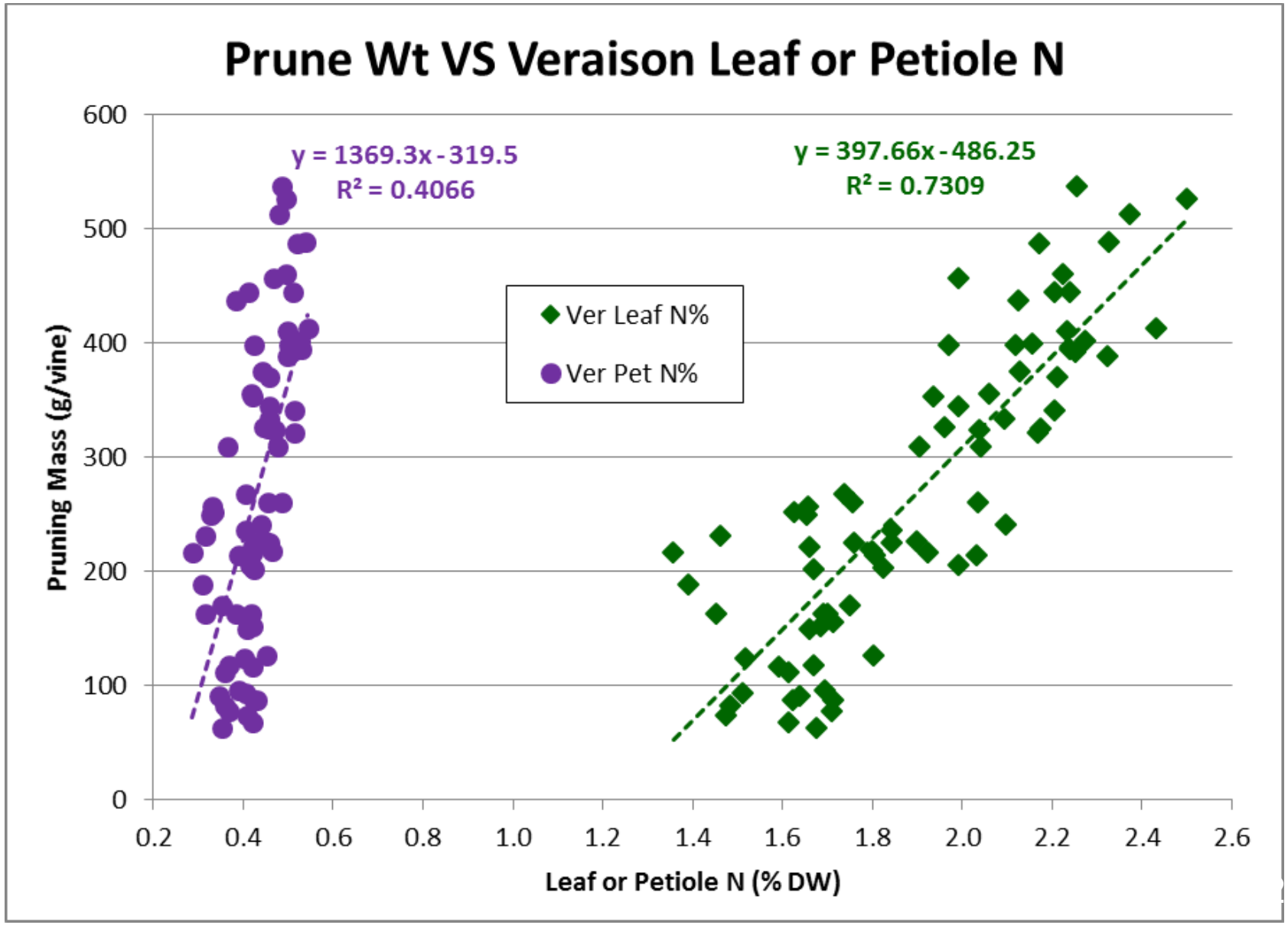
HortScience 52(1):174–184. 2017. doi: 10.21273/HORTSCI11405-16

Leaf Blade versus Petiole Nutrient Tests as Predictors of Nitrogen, Phosphorus, and Potassium Status of 'Pinot Noir' Grapevines

R. Paul Schreiner[1] and Carolyn F. Scagel
USDA-ARS-Horticultural Crops Research Unit, 3420 NW Orchard Avenue, Corvallis, OR 97330

Additional index words. must nutrients, nutrient concentrations, tissue tests, *Vitis vinifera*, YAN

Results - Controlled PIP Trial



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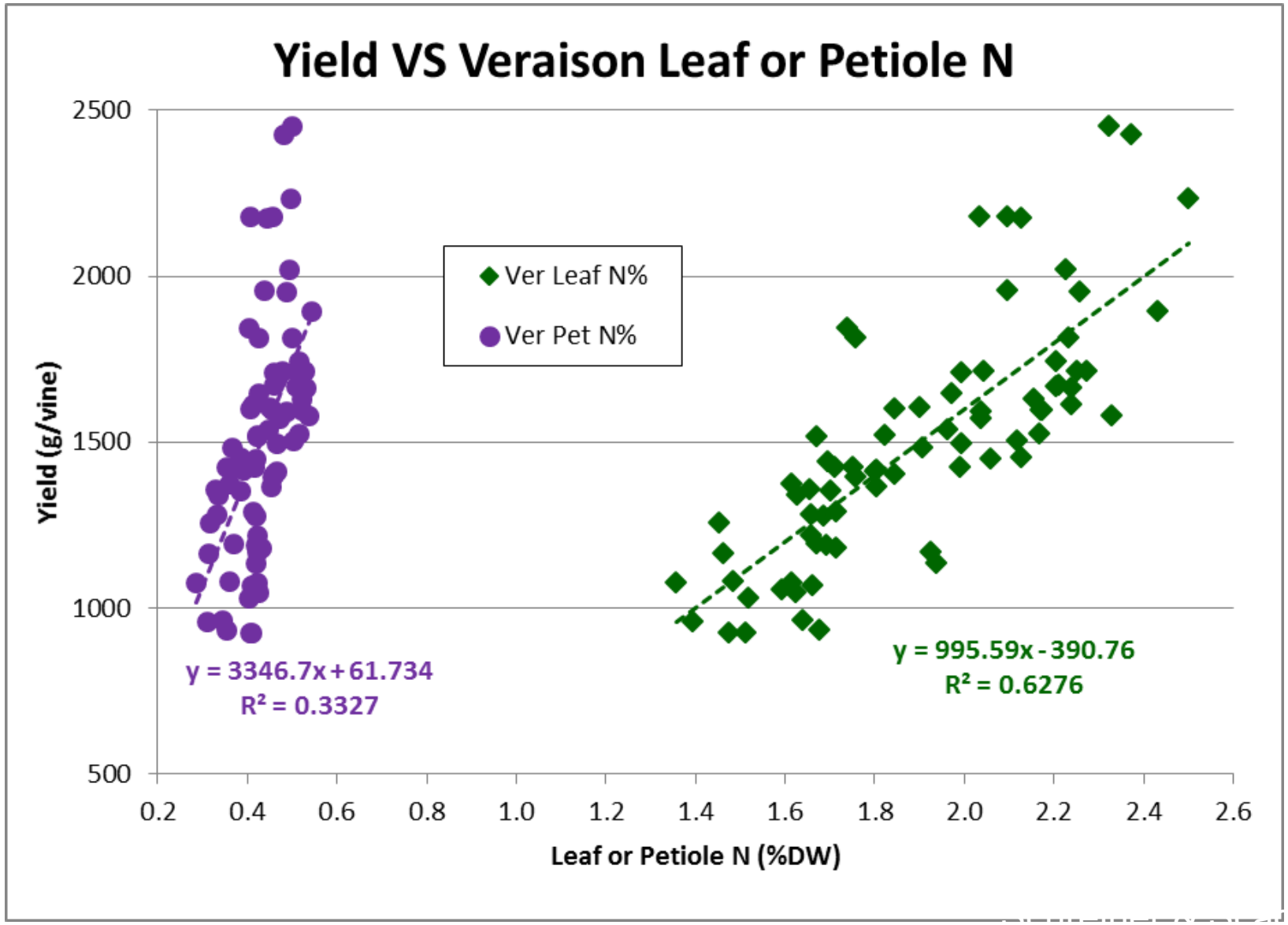

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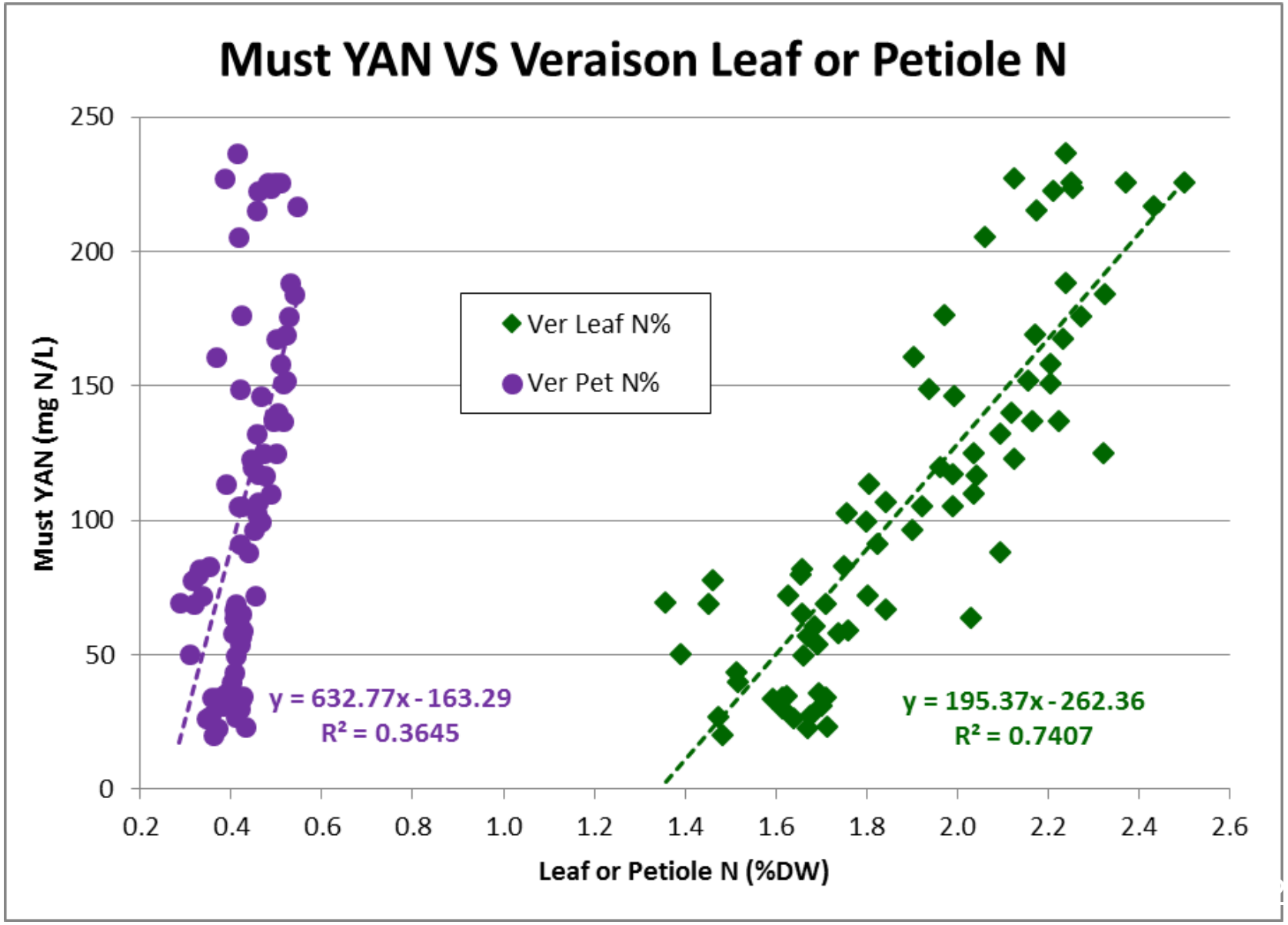
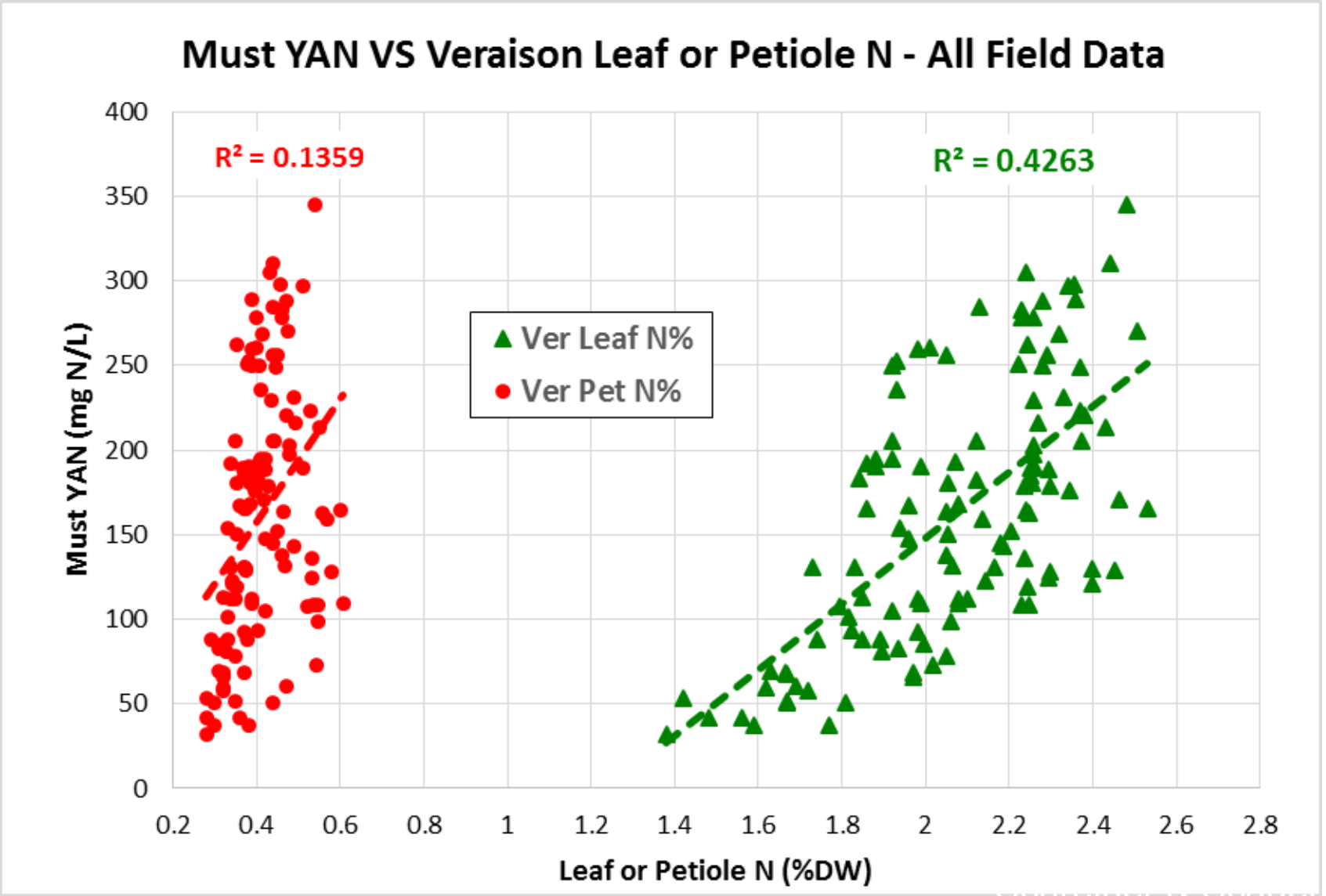


Results - Pinot noir Field *YAN only*



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 (particularly in different years).
- P & K - blade and petiole similar by this analysis (data not shown), but in other work blade was better.
- Blades should be used in routine testing of grapevine nutrients!

Dubious Results for Petiole Nitrate Tests

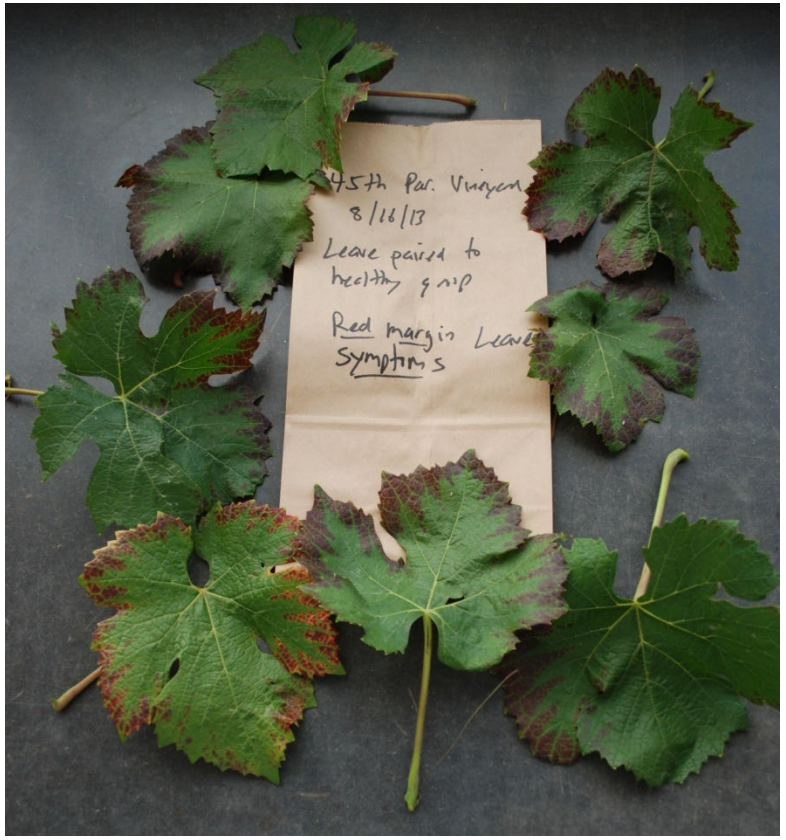
Courtesy of Ste. Michelle Wine Estates

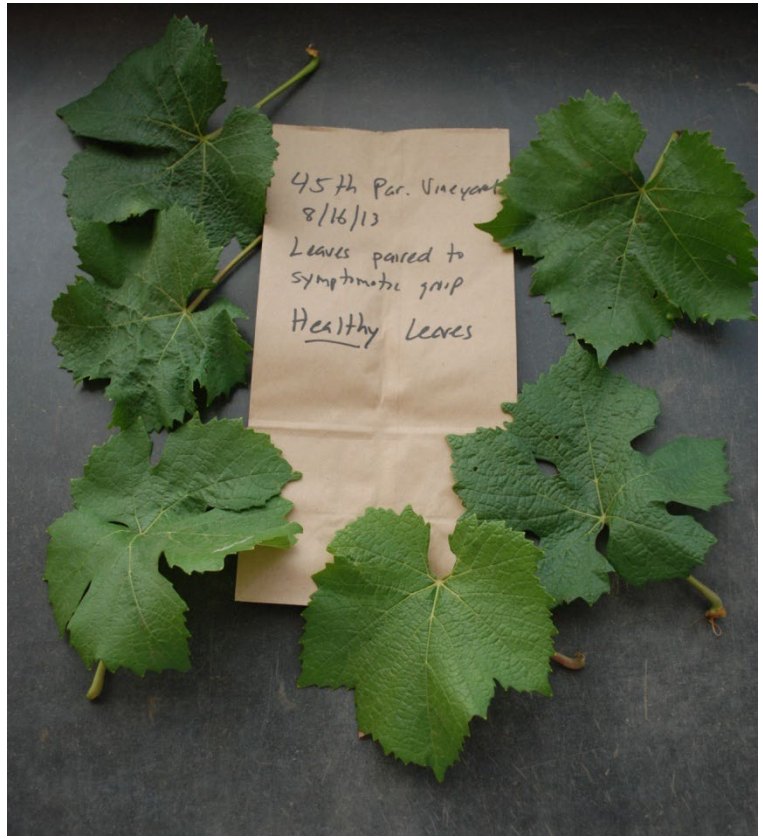
Case Study for Nutrient testing in Pinot noir ?

- Use of Paired Sampling

Willamette Valley Pinot noir
Vineyard at Veraison

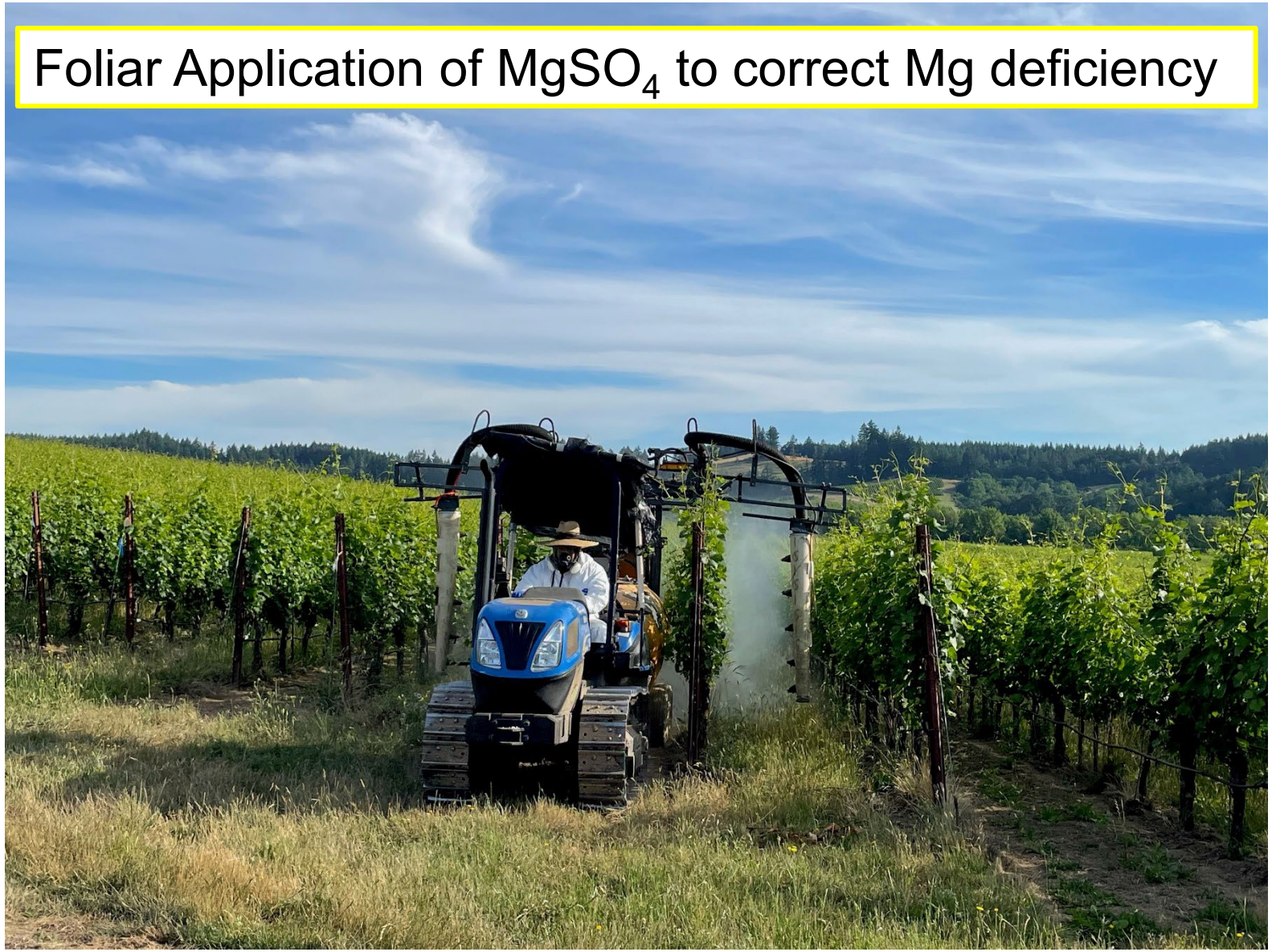
Paired Sampling to Diagnosis (Confirm) which Nutrient is Deficient





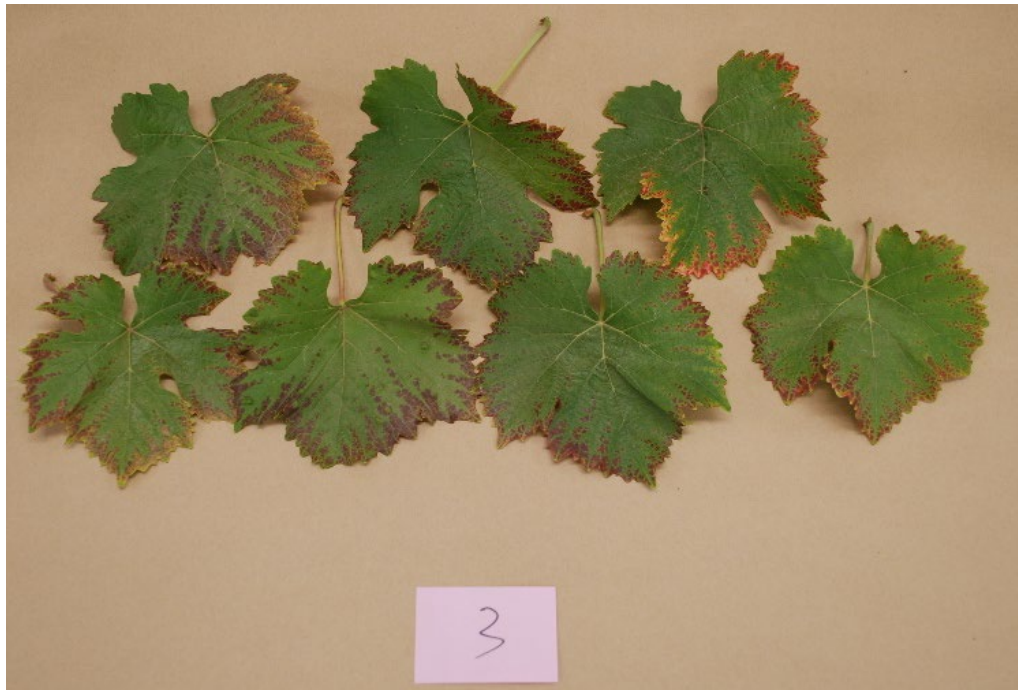
0.08%	Leaf Mg	0.16%
0.20%	Leaf P	0.19%
0.20%	Petiole Mg	0.19%

2021 Mg Trial - Pinot noir

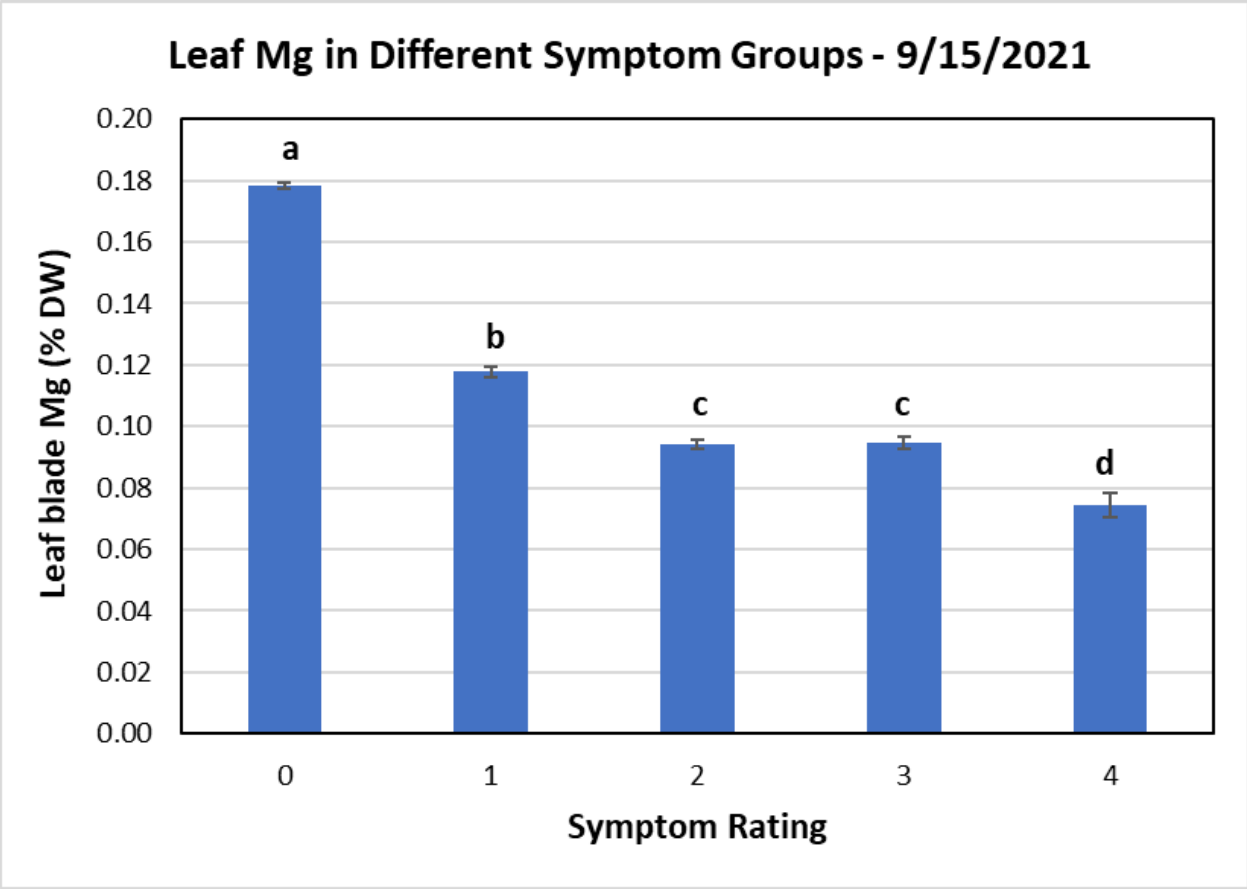


HiRes Vineyard
NUTRITION

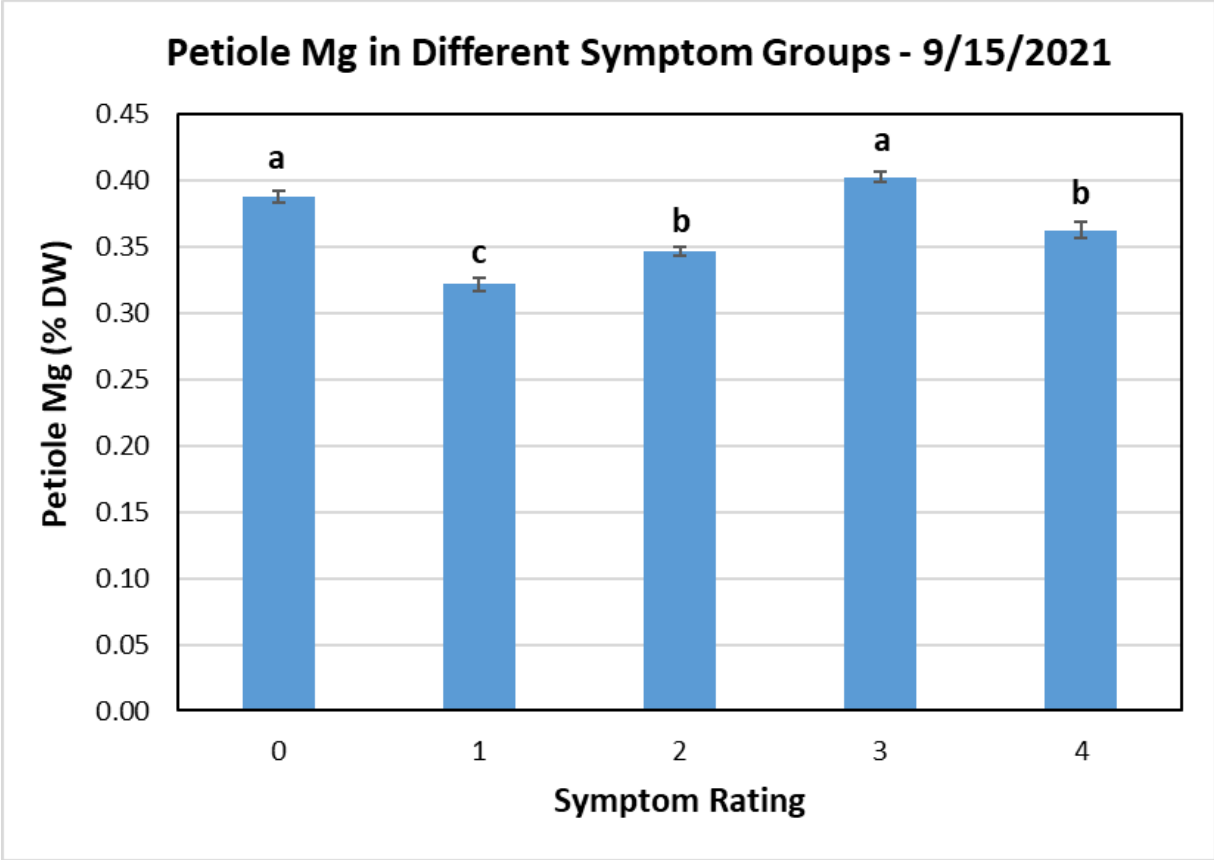
Leaf Mg deficiency symptom classes in Pinot noir to analyze Mg levels – Sep 15, 2021



Leaf Blade Mg diagnoses Symptoms



Petioles DO NOT !!!!!



Confirms Prior Findings - *Schreiner and Scagel 2017*

Do Nutrient Concentrations in Dormant Canes Respond to Varying Inputs ?

Can Nutrient Concentrations in Dormant Canes Predict Nutrient Status for the Next Growing Season?

Data from Pot-in-pot Vineyard were used:
(N, P, & K Supply was carefully controlled)

JOURNAL OF PLANT NUTRITION
2021, VOL. 44, NO. 2, 238–251
https://doi.org/10.1080/01904167.2020.1806311

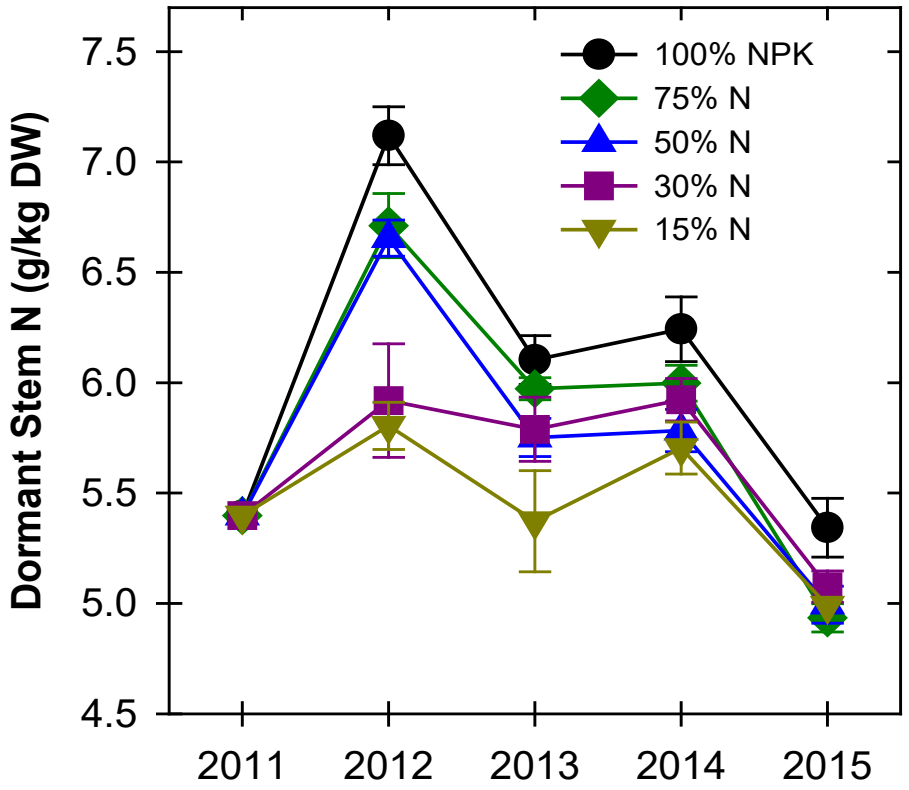
Utility of dormant season pruning wood to predict nutrient status of grapevines

R. Paul Schreiner

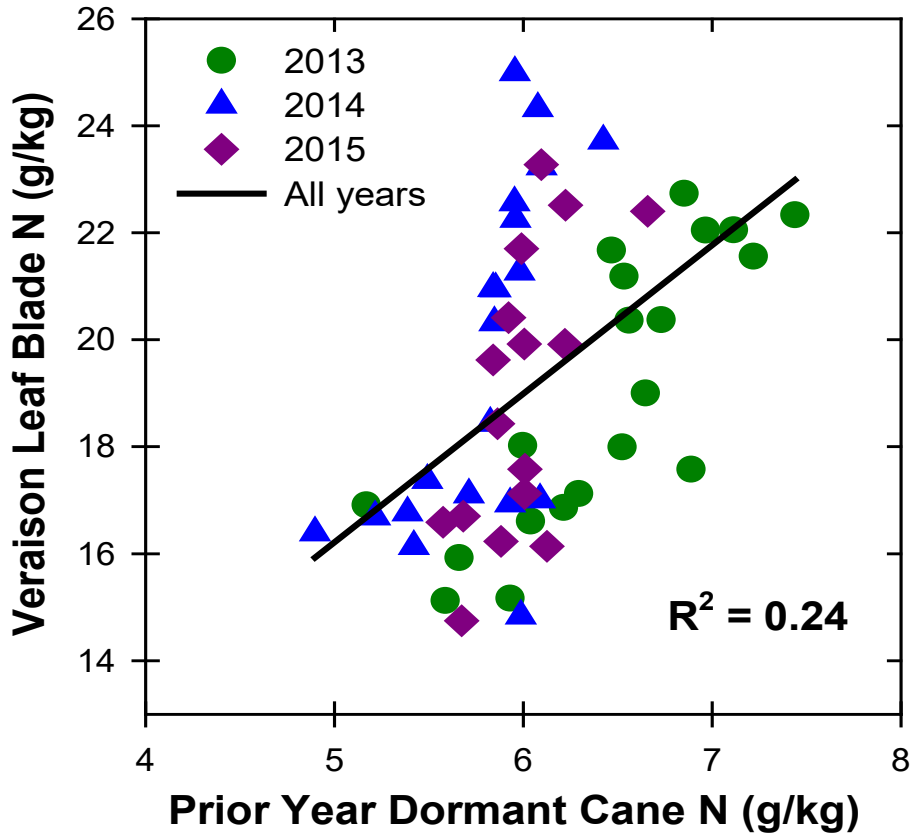
Horticultural Crops Research Unit, USDA-ARS, Corvallis, OR, USA

Results for Nitrogen:

Tissue Response

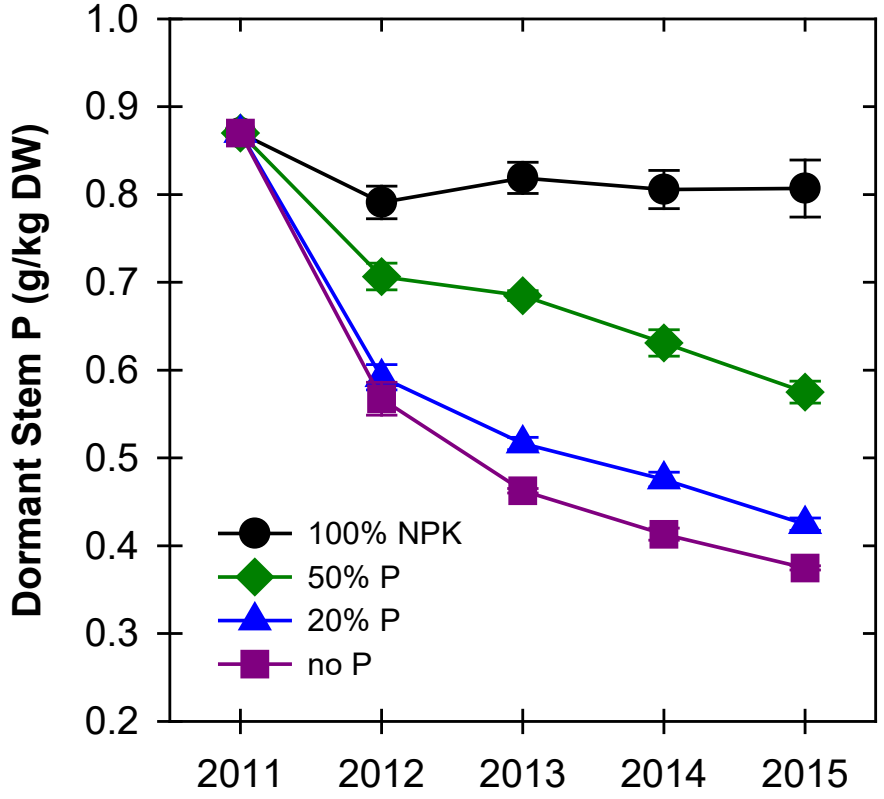


Predictive Ability

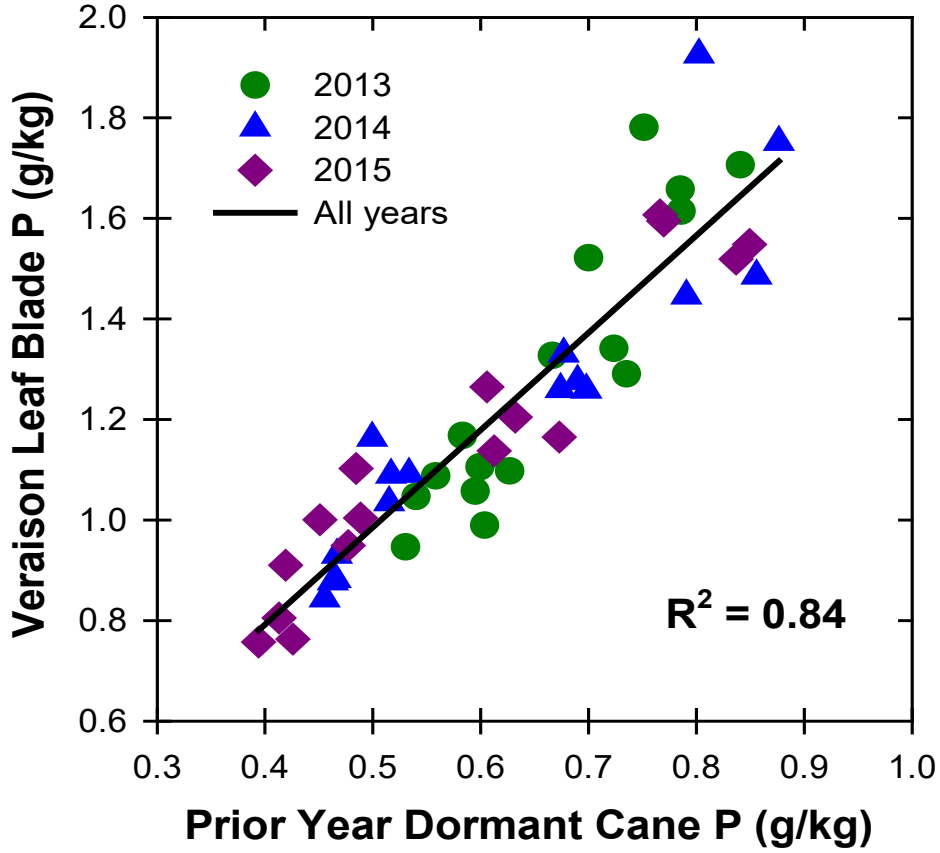


Results for Phosphorus:

Tissue Response

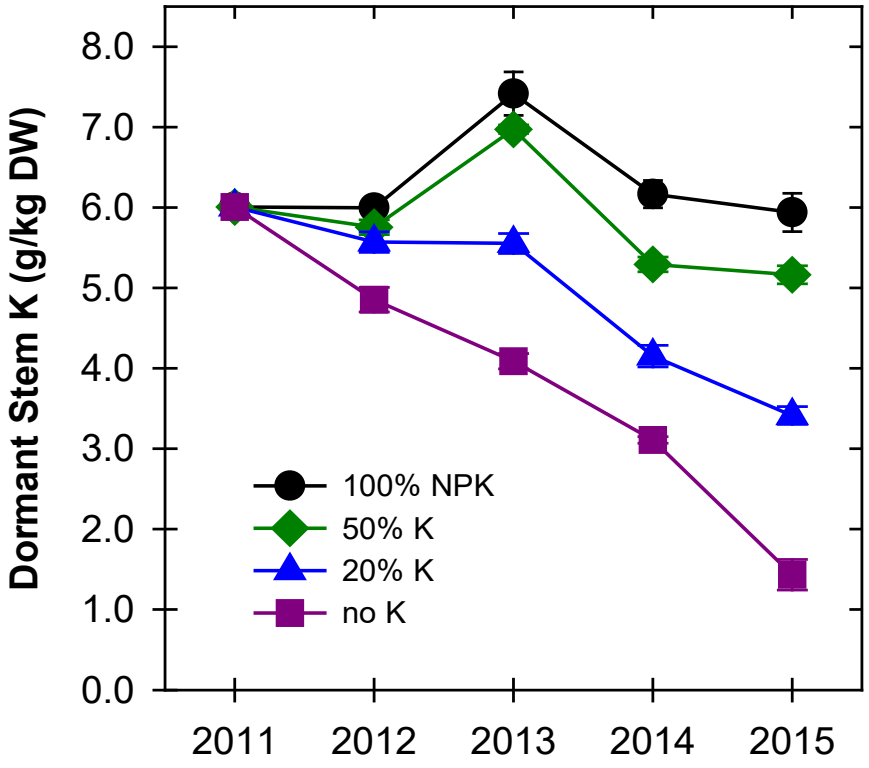


Predictive Ability

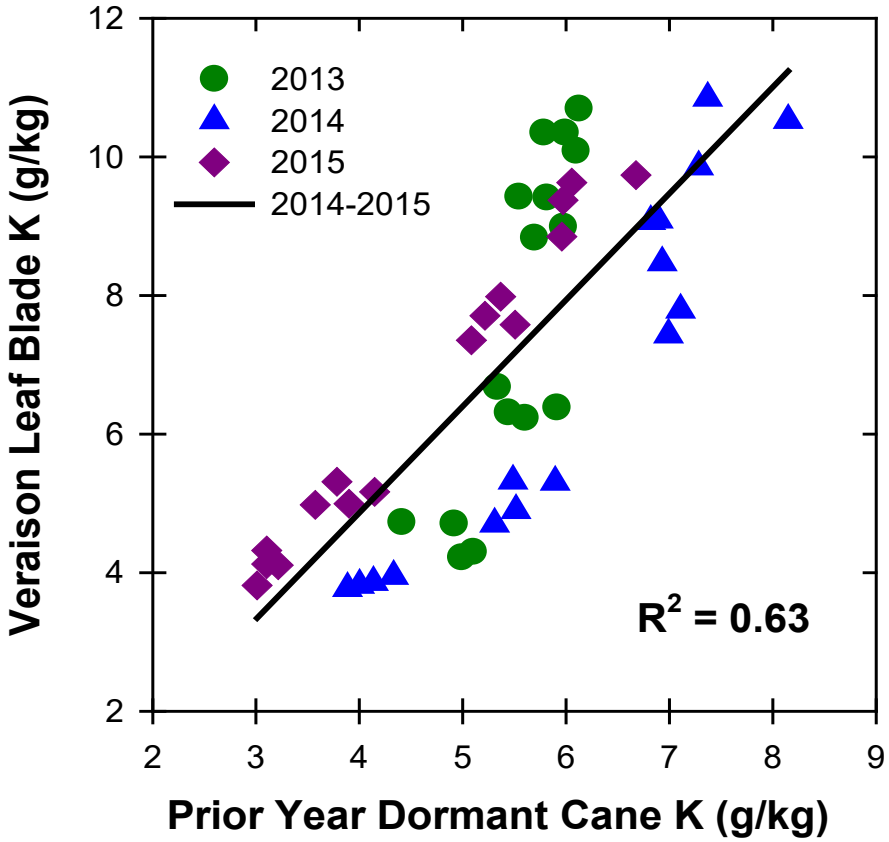


Results for Potassium:

Tissue Response



Predictive Ability



[redacted]

[redacted]

Plant Analysis

Submitted By: UMC00047

[redacted]

Submitted For: [redacted]

Bloom Petiole
CH Eastern OR

Laboratory Sample #
BG93117

Date Received:
06/05/2018

Date Processed:
06/06/2018

Information Sheet #
P0054

Sample Marked: [redacted]

Laboratory Turnaround: 1 Day

Samples Will Be Stored Until: 20-Jun-18

Crop: GRAPE

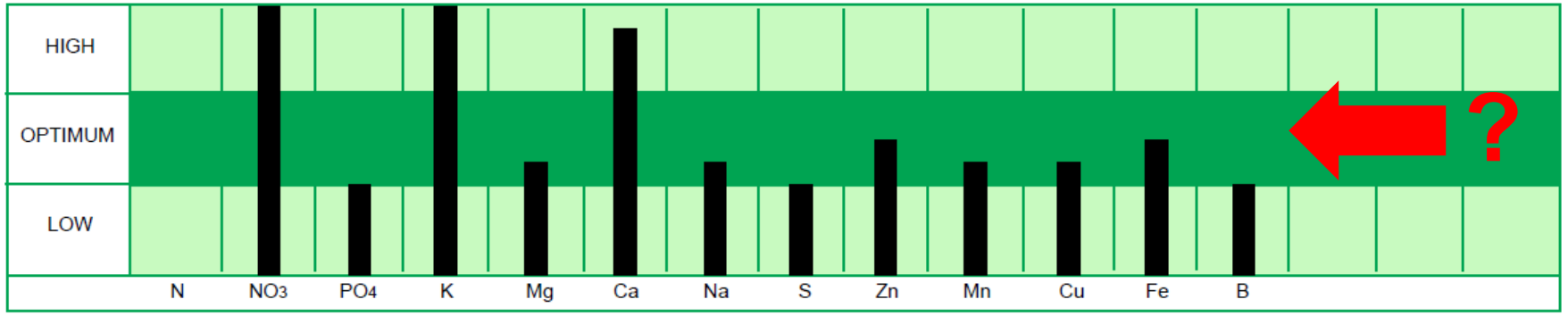
Plant Part: PETIOLE

Results of Laboratory Analysis

Laboratory Analysis		3032.5	0.243	4.09	0.33	1.97	138.00	0.16	34.10	34.7	11.4	44.1	38.1			
	% Nitrogen	ppm Nitrate	PO_4	% Potassium	% Magnesium	% Calcium	ppm Sodium	% Sulfur	ppm Zinc	ppm Manganese	ppm Copper	ppm Iron	ppm Boron			

Graphic Rating of Results Compared to Normal Ranges

Normal Ranges	to	599 to 1200	0.29 to 0.6	1.49 to 2.5	0.24 to 0.8	0.79 to 1.2	0 to 1400	0.16 to 0.32	24 to 50	25 to 150	10 to 25	30 to 60	39 to 60			



Comments:

Vine Nutrition Guidelines for Oregon Wine Grape Vineyards (updated May, 2022)

			Petiole		Leaf Blade (Preferred)		
Nutrient	**Sample timing**	**Units**	**Deficient**	**Excessive**	**Deficient**	**Safe/Healthy**	**Excessive**
N	bloom	**%**	**0.60 - 0.70**		**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**	**> 0.12**	
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/véraison	**%**	**0.9 - 1.0**		**0.9 - 1.0**	**> 1.00**	
Mg	bloom/véraison	**%**	**0.20 – 0.50**		**0.10 – 0.20**	**> 0.25**	
Mn	bloom/véraison	**ppm**	**20**		**20**	**> 20**	
Zn	bloom/véraison	**ppm**	**20 - 25**		**15 - 20**	**> 20**	
B	bloom/véraison	**ppm**	**20 - 25**	**125**	**15 - 20**	**> 20**	**250**
Cu	bloom/véraison	**ppm**	**3 - 5**	**25 - 50**	**3 - 5**	**> 5**	

Data shown are based on nutrition research for wine grapes in Oregon with comparison to other regions. Deficient levels for nitrogen (N), phosphorus (P), and potassium (K) are well characterized for Pinot noir. Véraison samples are more reliable than bloom samples for diagnosing most nutrients. Levels from leaf blades at véraison are more reliable than petioles for diagnosing N, P, K, and Mg. *Source: Paul Schreiner, USDA-ARS, Hort Crops Research Lab, Corvallis, OR.*

Microplot Projects to Find OPTIMAL NPK for Pinot noir

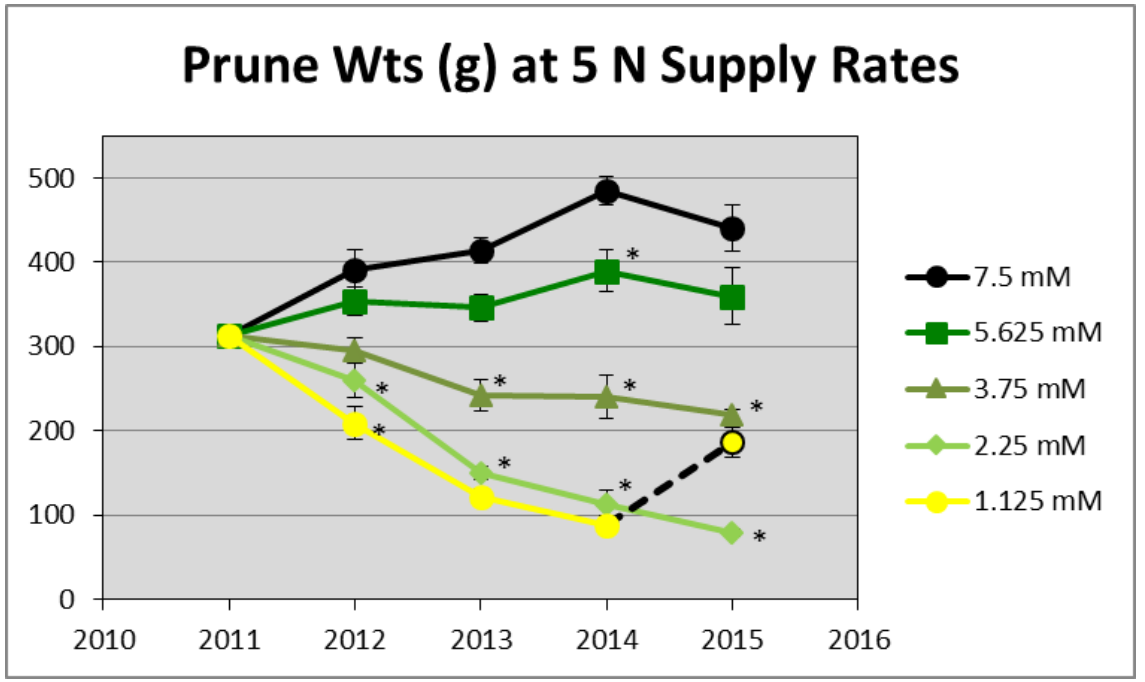
Manipulating N, P, & K in Sand 2006-2008

Manipulating N, P, & K in Sandy Soil 2012-2015

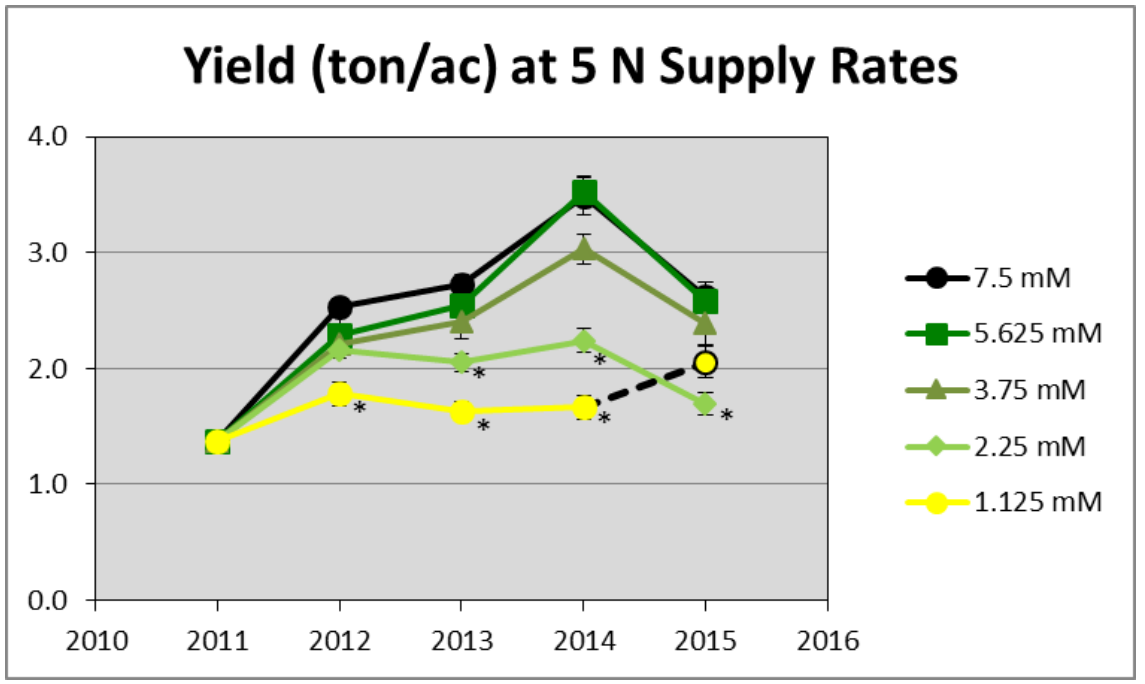
NPK 2

N Supply

Vegetative →



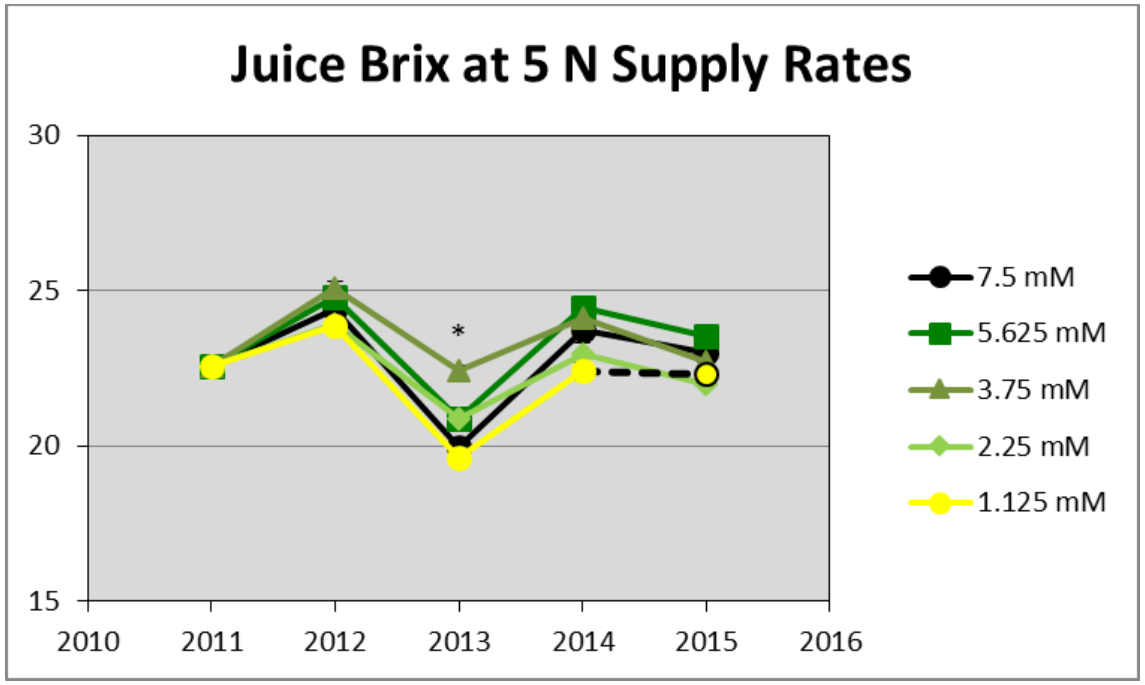
Reproductive →

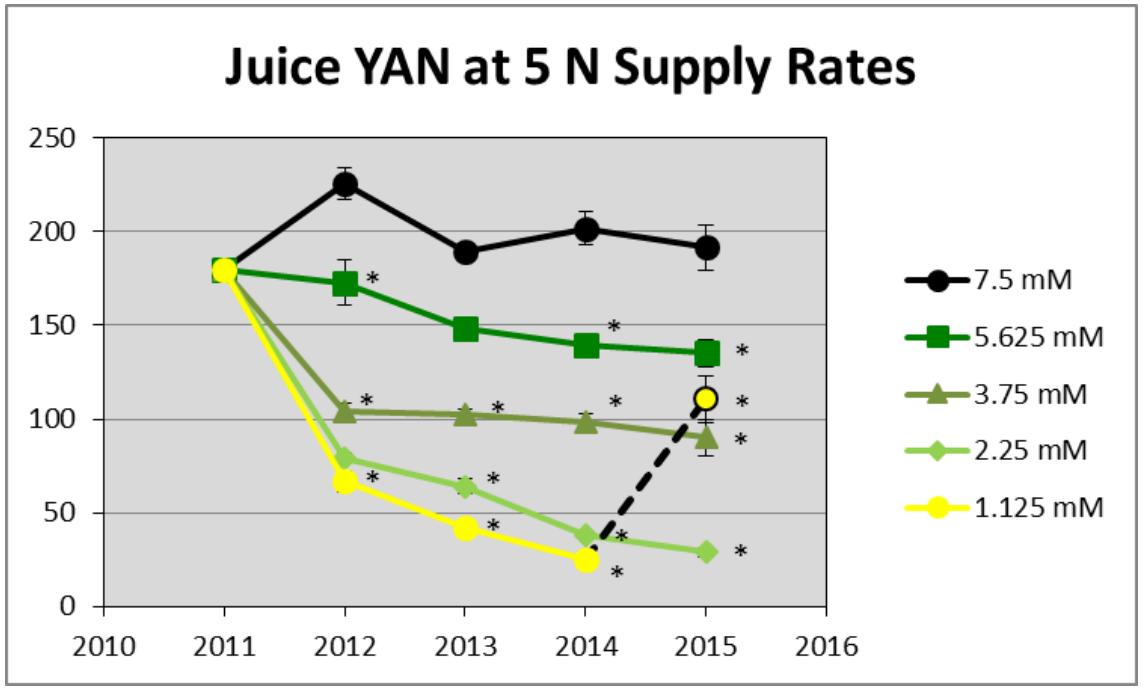


NPK 2

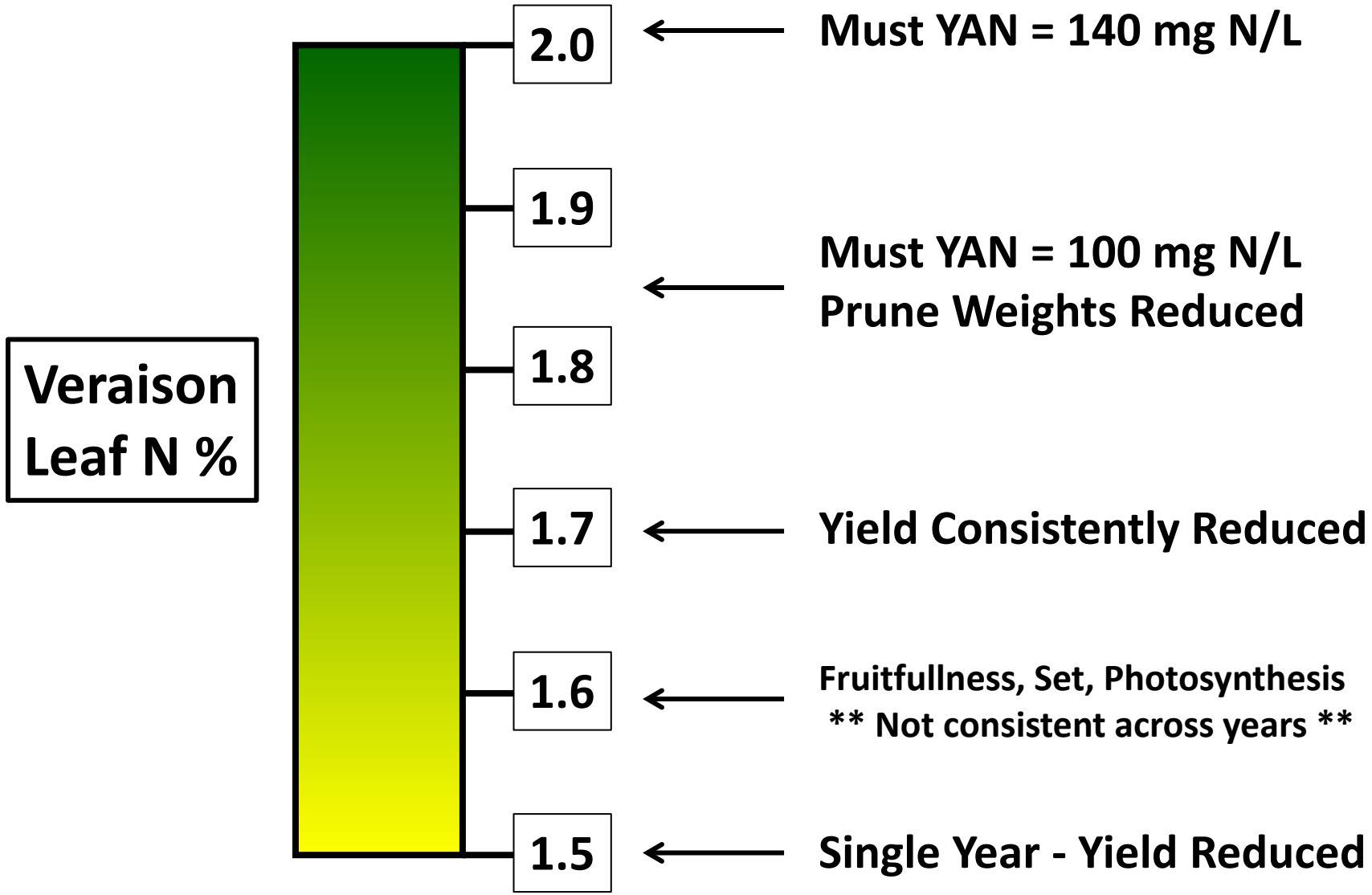
N Supply

Effects on Must





Impact of N Status on Pinot noir Performance

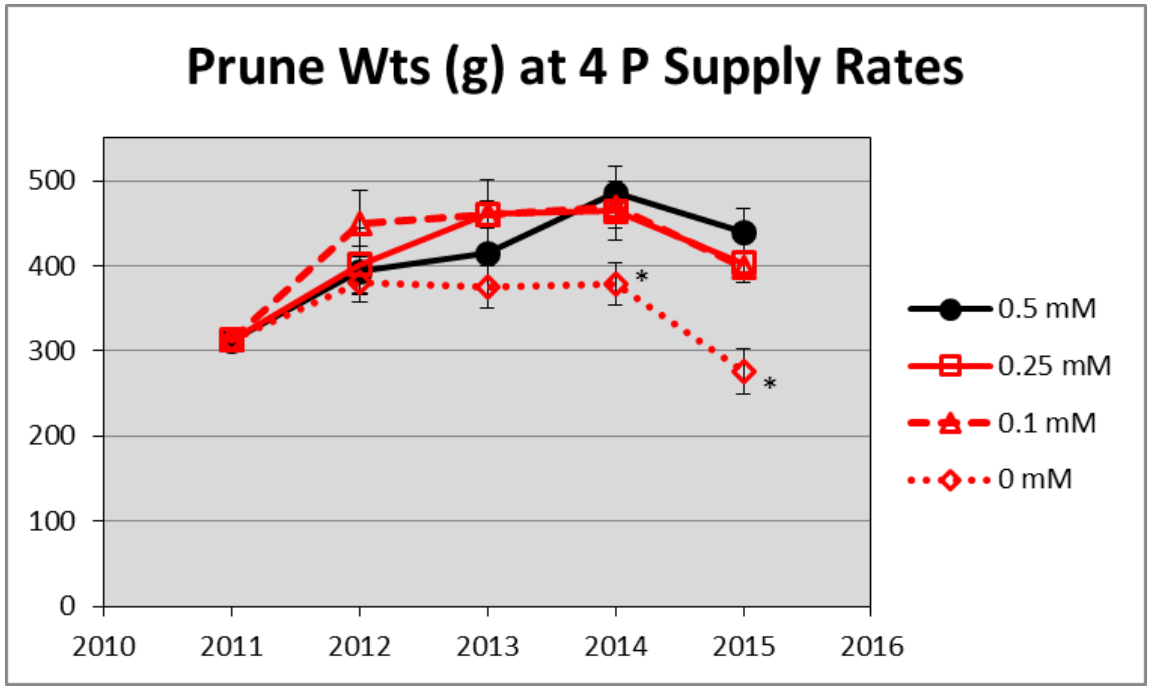


P findings from NPK 2

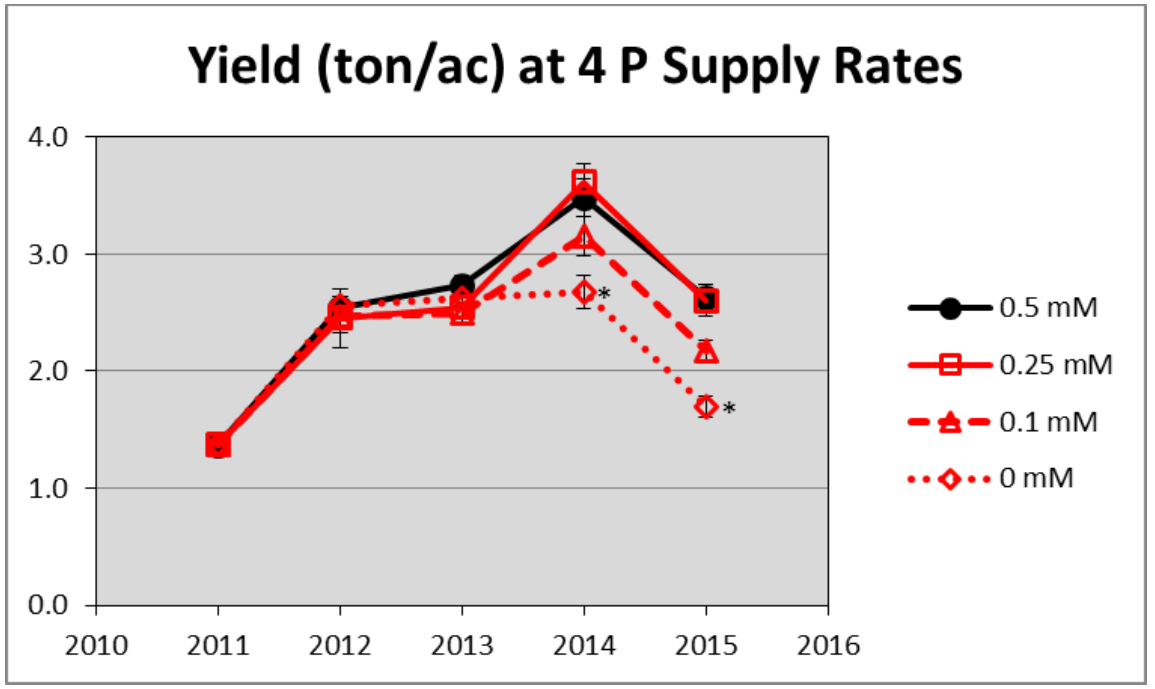
NPK 2

P Supply

Vegetative →



Reproductive →



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 or fruit set in Pinot noir (Cultivar Variation).
- No impact of low must **P** on fermentation or on berry or 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)**

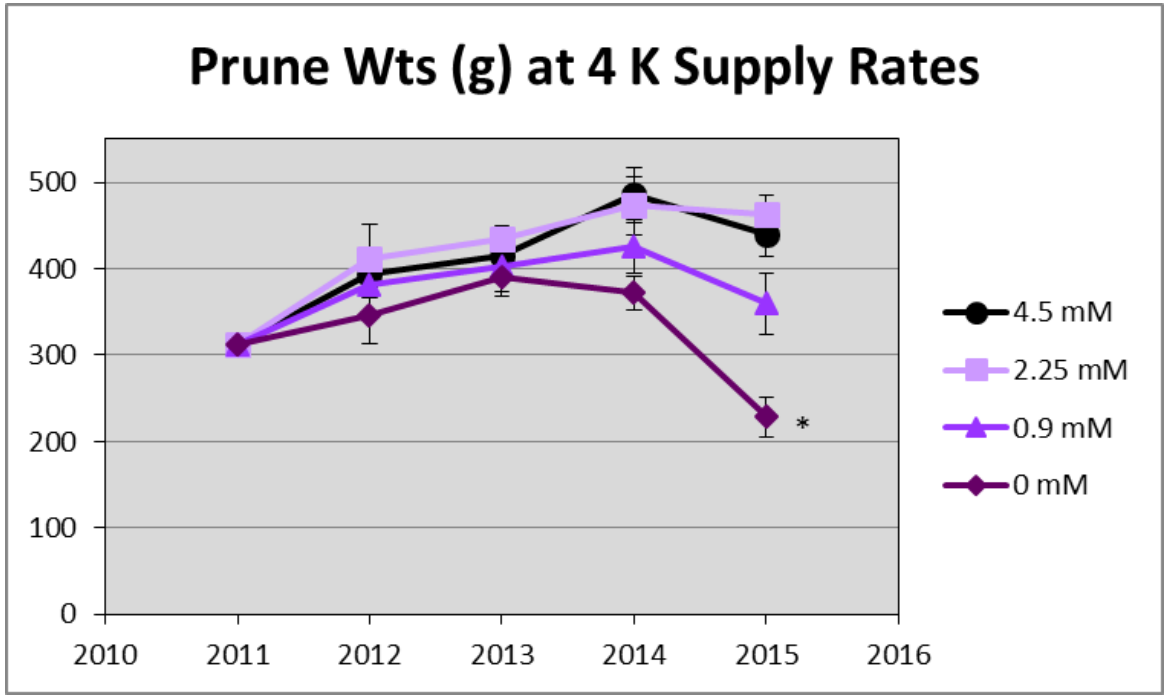
K findings from NPK 2

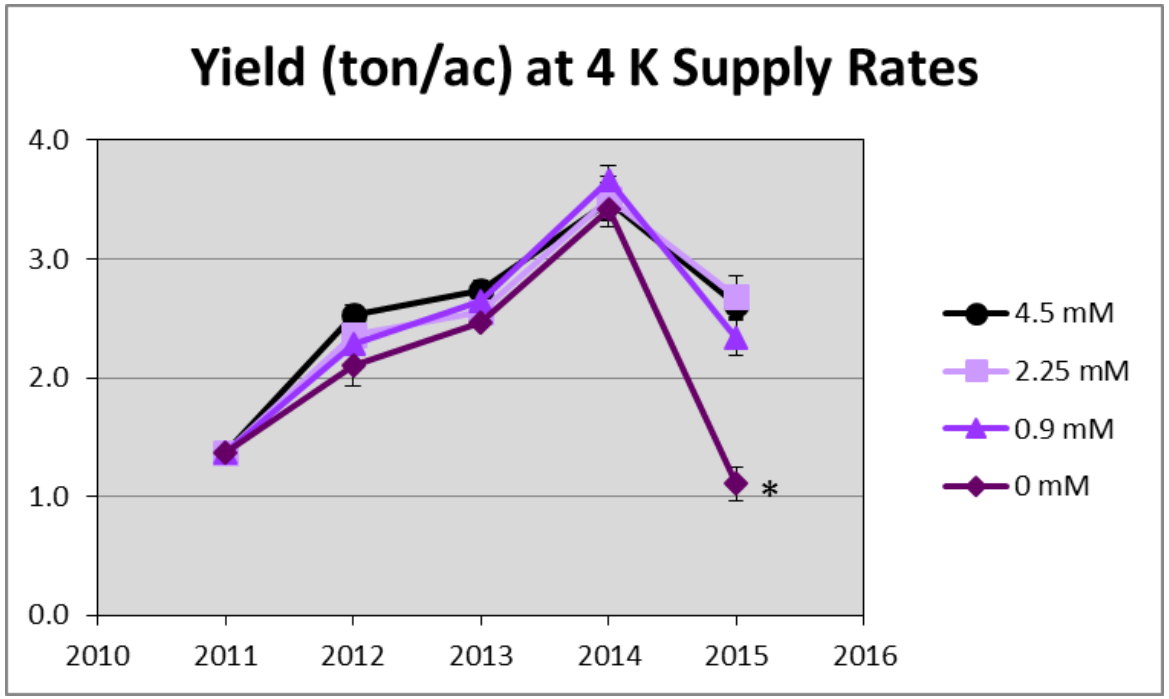
NPK 2

K Supply

Vegetative →

Reproductive →



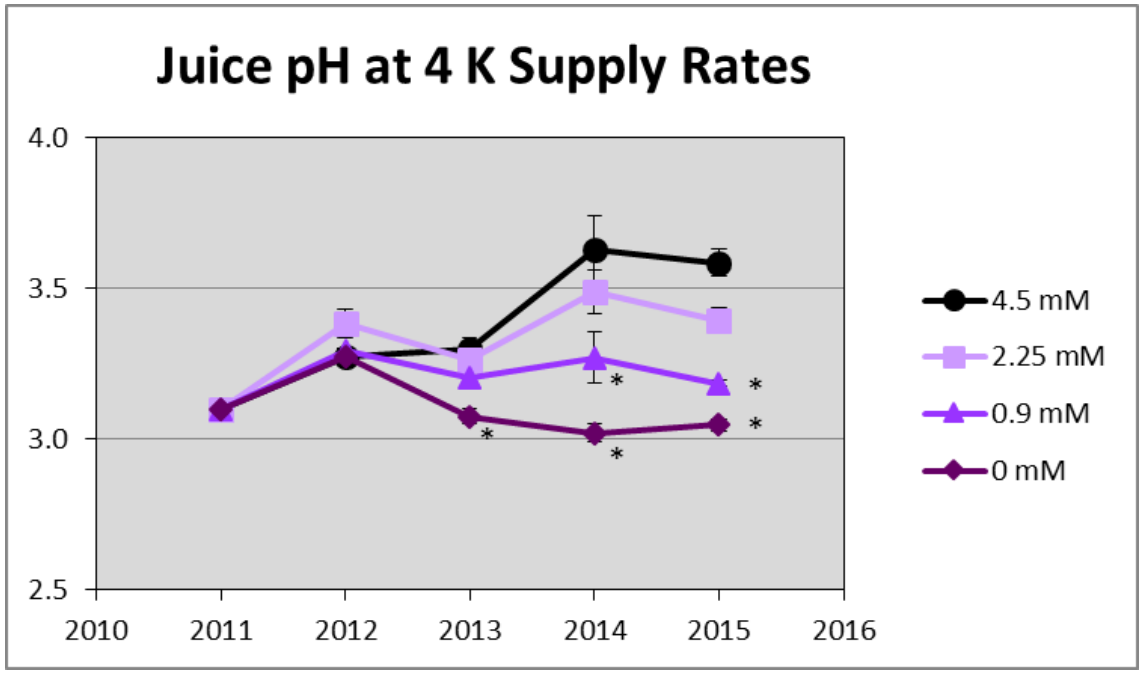


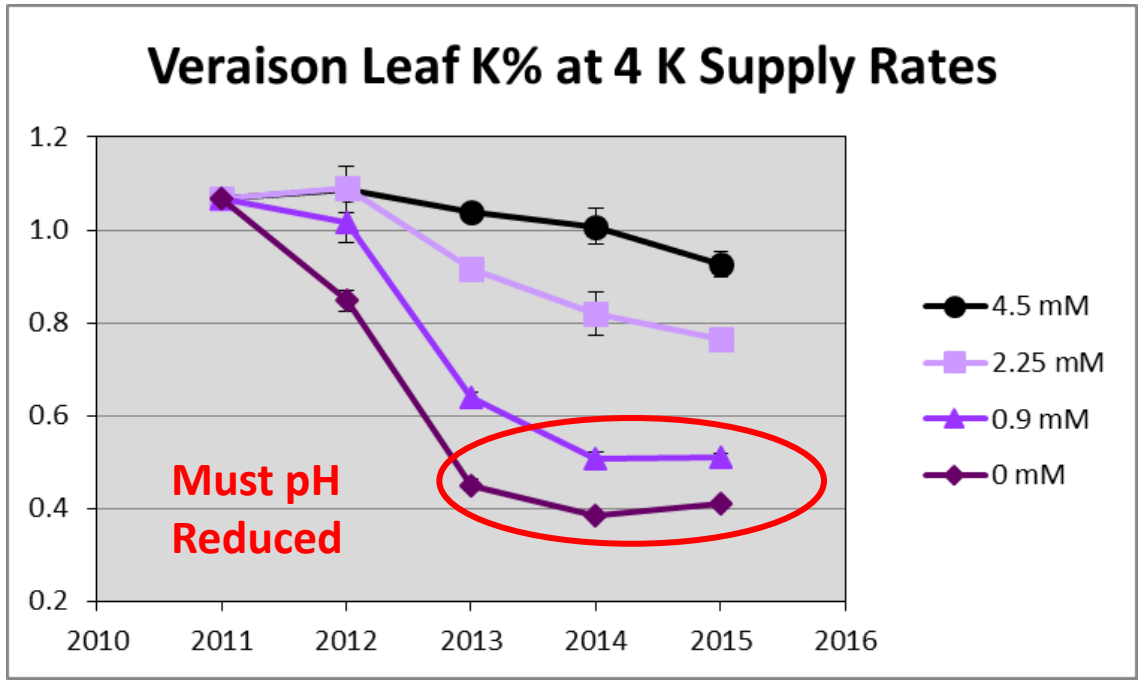
NPK 2

K Supply

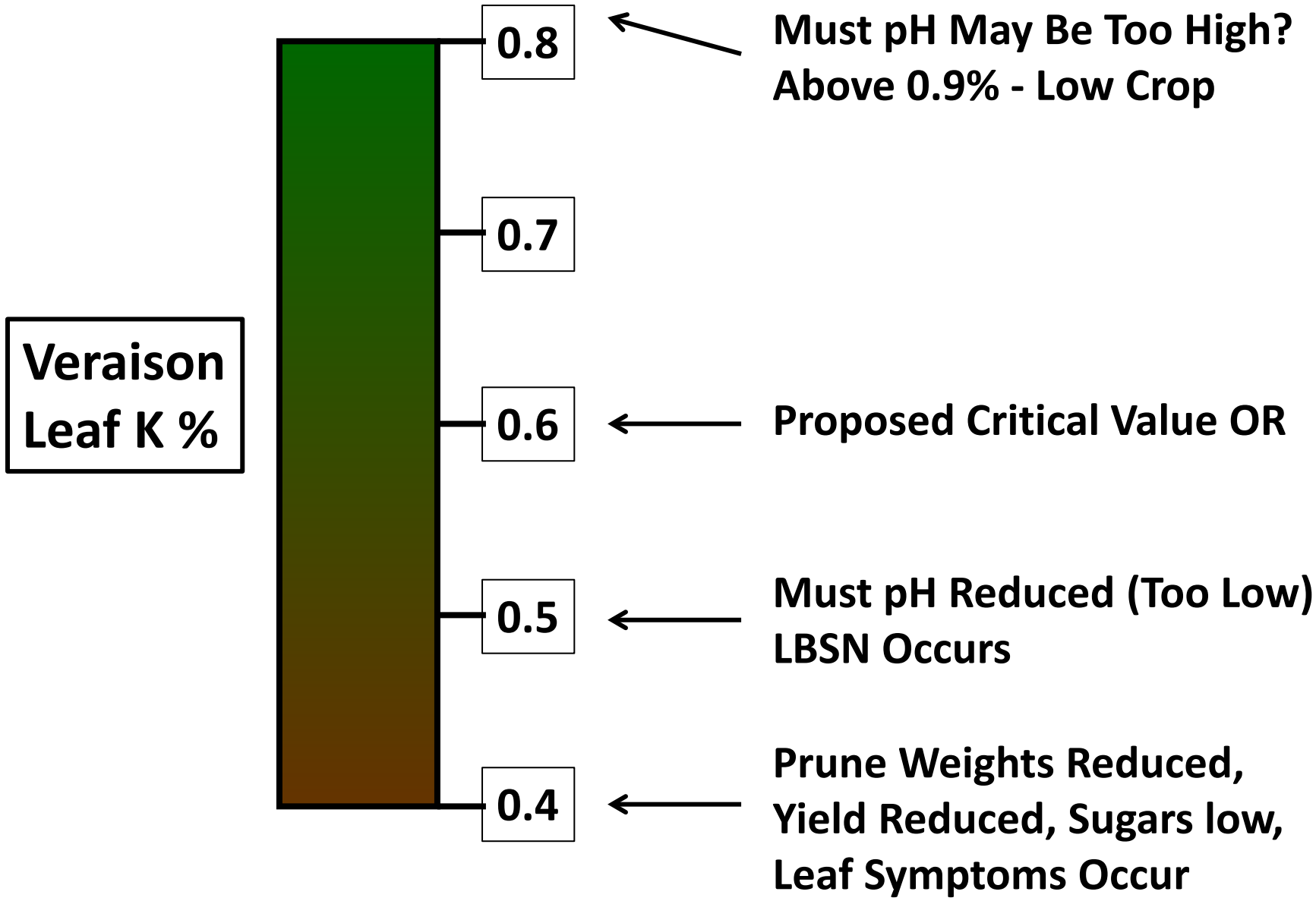
Effects on pH in Must

Occurs when leaf K ≤ 0.5%





Impact of K Status on Pinot noir Performance



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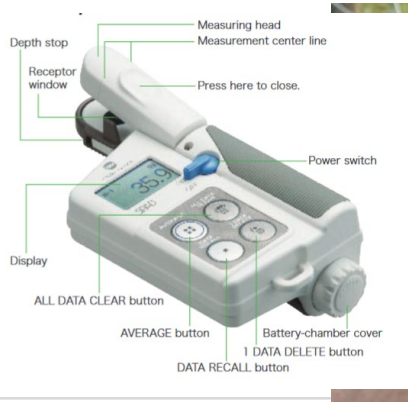
			Petiole		Leaf Blade (Preferred)		
Nutrient	**Sample timing**	**Units**	**Deficient**	**Excessive**	**Deficient**	**Safe/Healthy**	**Excessive**
N	bloom	**%**	**0.60 - 0.70**		**2.20**	**> 2.40**	**4.25**
	véraison	**%**	**0.35 - 0.40**		**1.80**	**> 2.00**	**2.50**
P	bloom	**%**	**0.15**		**0.17**	**> 0.20**	
	véraison	**%**	**0.05**		**0.10**	**> 0.12**	
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/véraison	**%**	**0.9 - 1.0**		**0.9 - 1.0**	**> 1.00**	
Mg	bloom/véraison	**%**	**0.20 – 0.50**		**0.10 – 0.20**	**> 0.25**	
Mn	bloom/véraison	**ppm**	**20**		**20**	**> 20**	
Zn	bloom/véraison	**ppm**	**20 - 25**		**15 - 20**	**> 20**	
B	bloom/véraison	**ppm**	**20 - 25**	**125**	**15 - 20**	**> 20**	**250**
Cu	bloom/véraison	**ppm**	**3 - 5**	**25 - 50**	**3 - 5**	**> 5**	

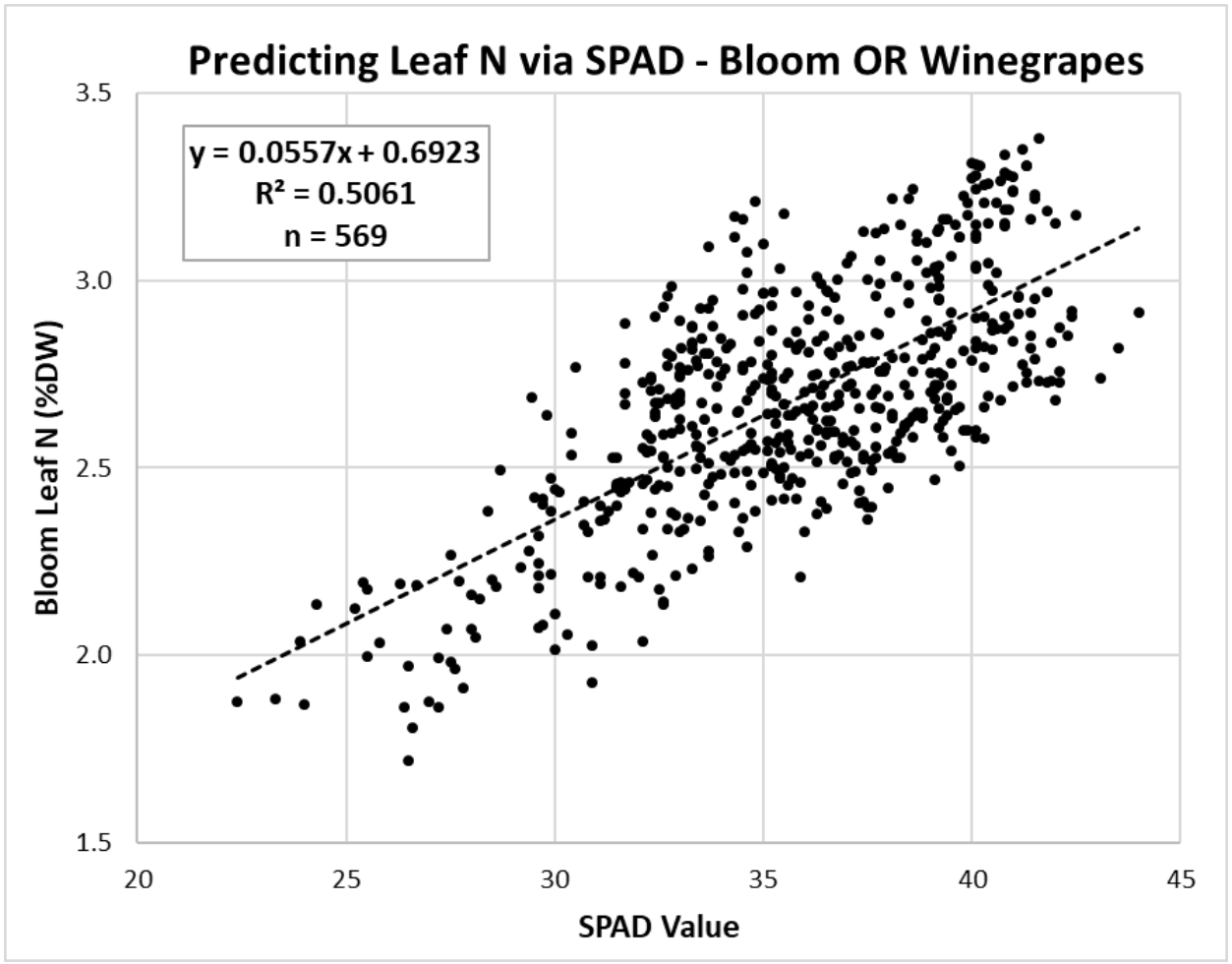
Data shown are based on nutrition research for wine grapes in Oregon with comparison to other regions. Deficient levels for nitrogen (N), phosphorus (P), and potassium (K) are well characterized for Pinot noir. Véraison samples are more reliable than bloom samples for diagnosing most nutrients. Levels from leaf blades at véraison are more reliable than petioles for diagnosing N, P, K, and Mg. *Source: Paul Schreiner, USDA-ARS, Hort Crops Research Lab, Corvallis, OR.*

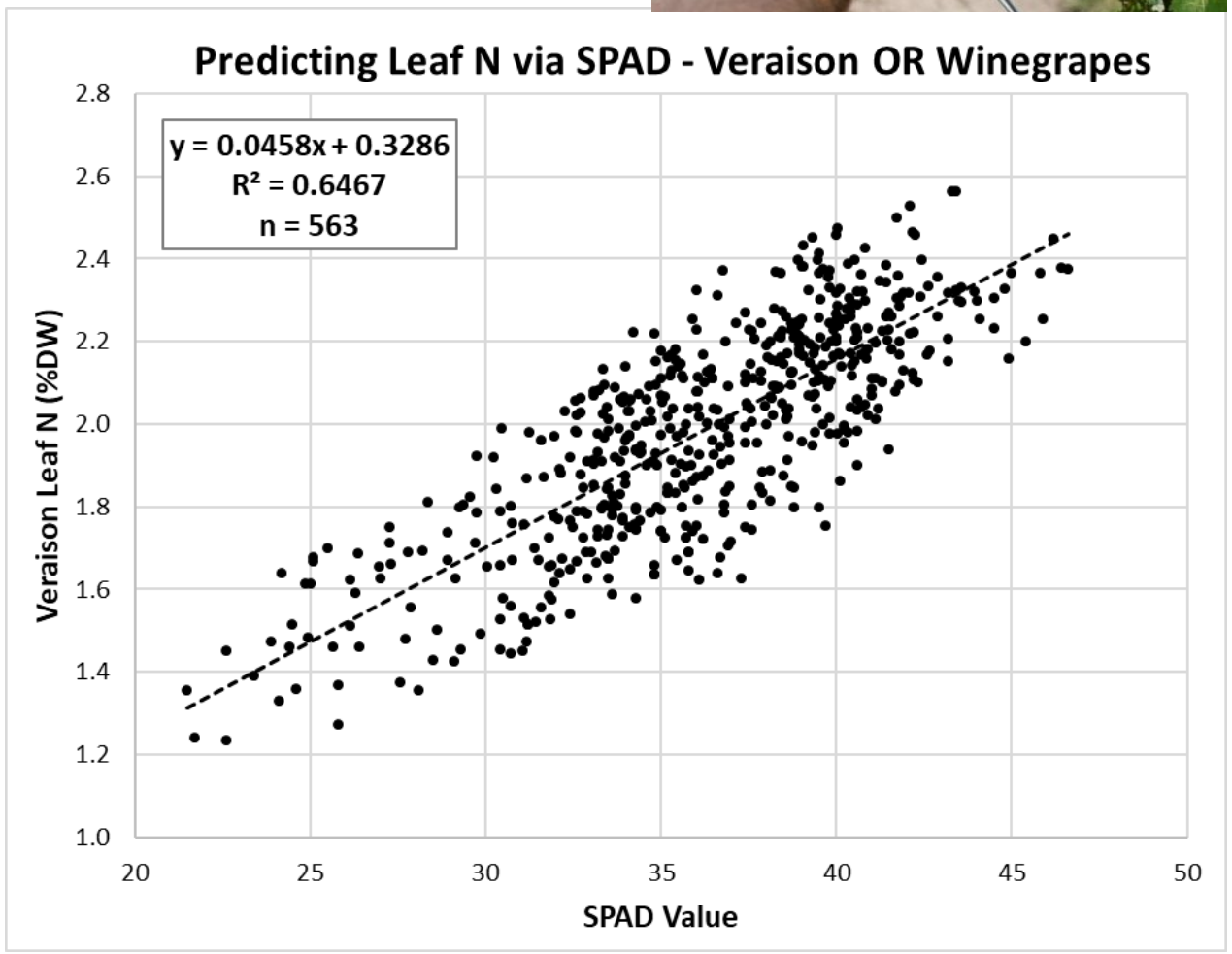
HiRes Vineyard
NUTRITION

New Tools for Predicting Nutrients

Can they beat old ones??



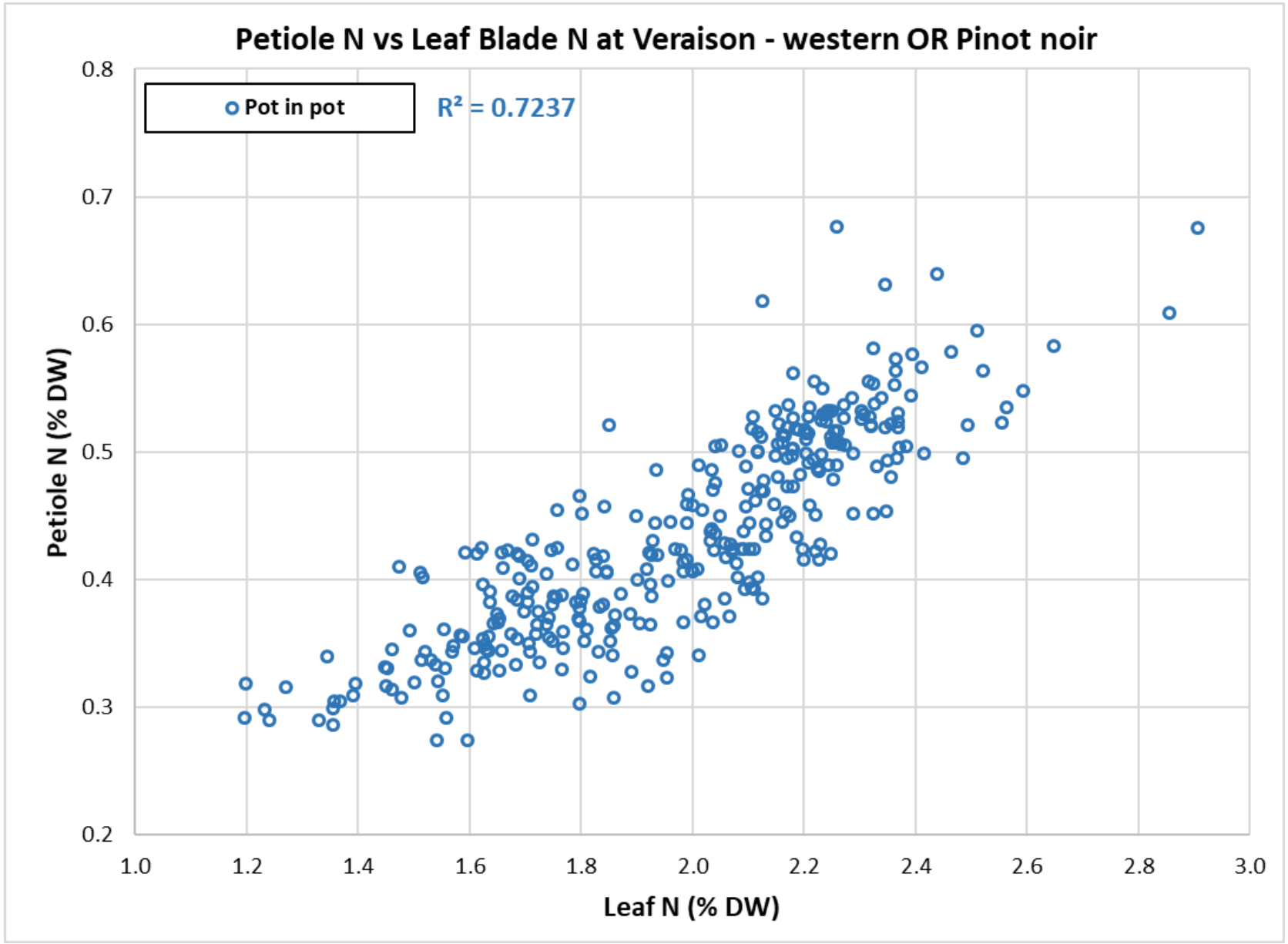




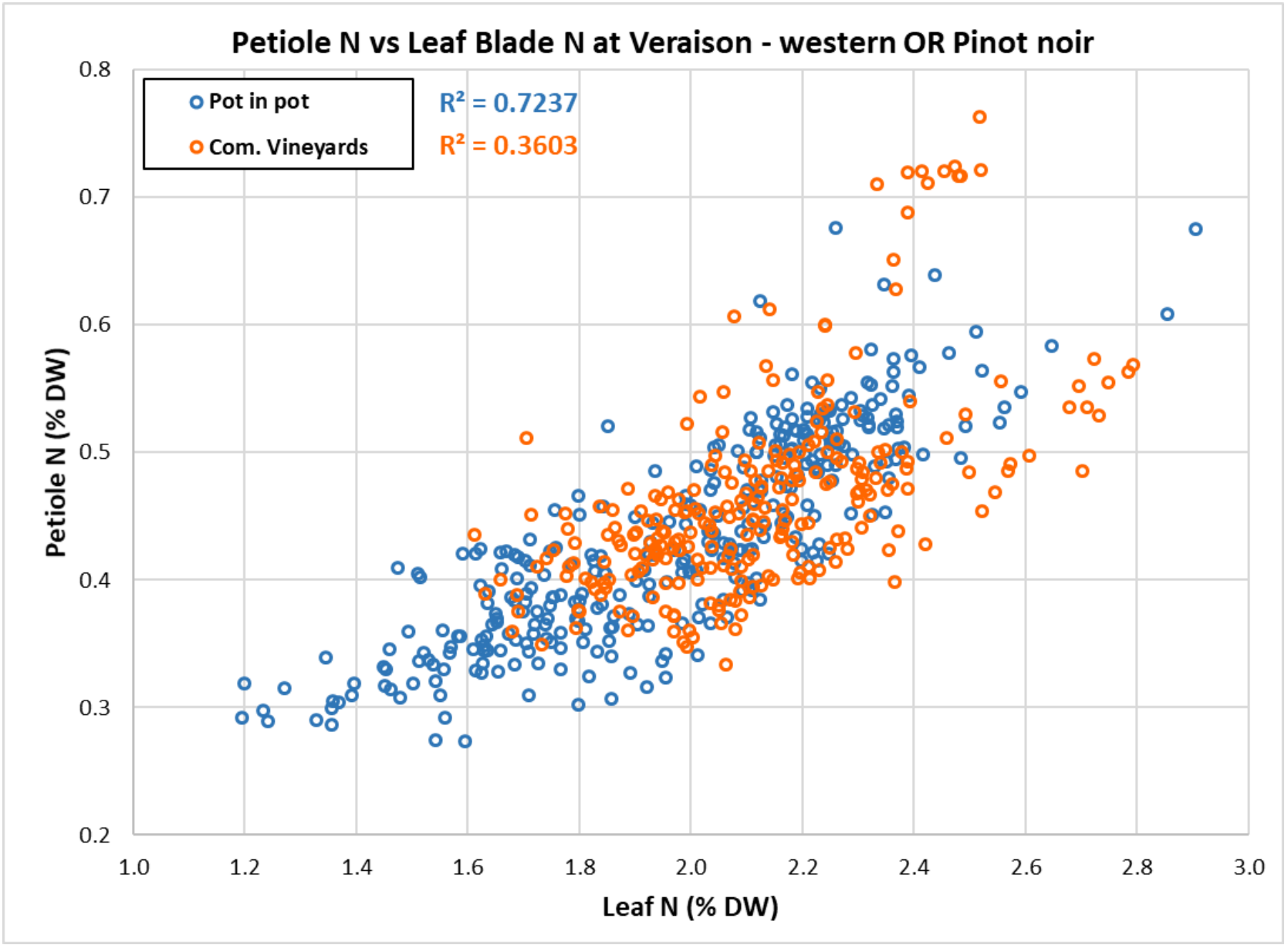
Conclusions:

- **Nutrient Data is only as good as the care & effort you place on careful sample collection & analysis**

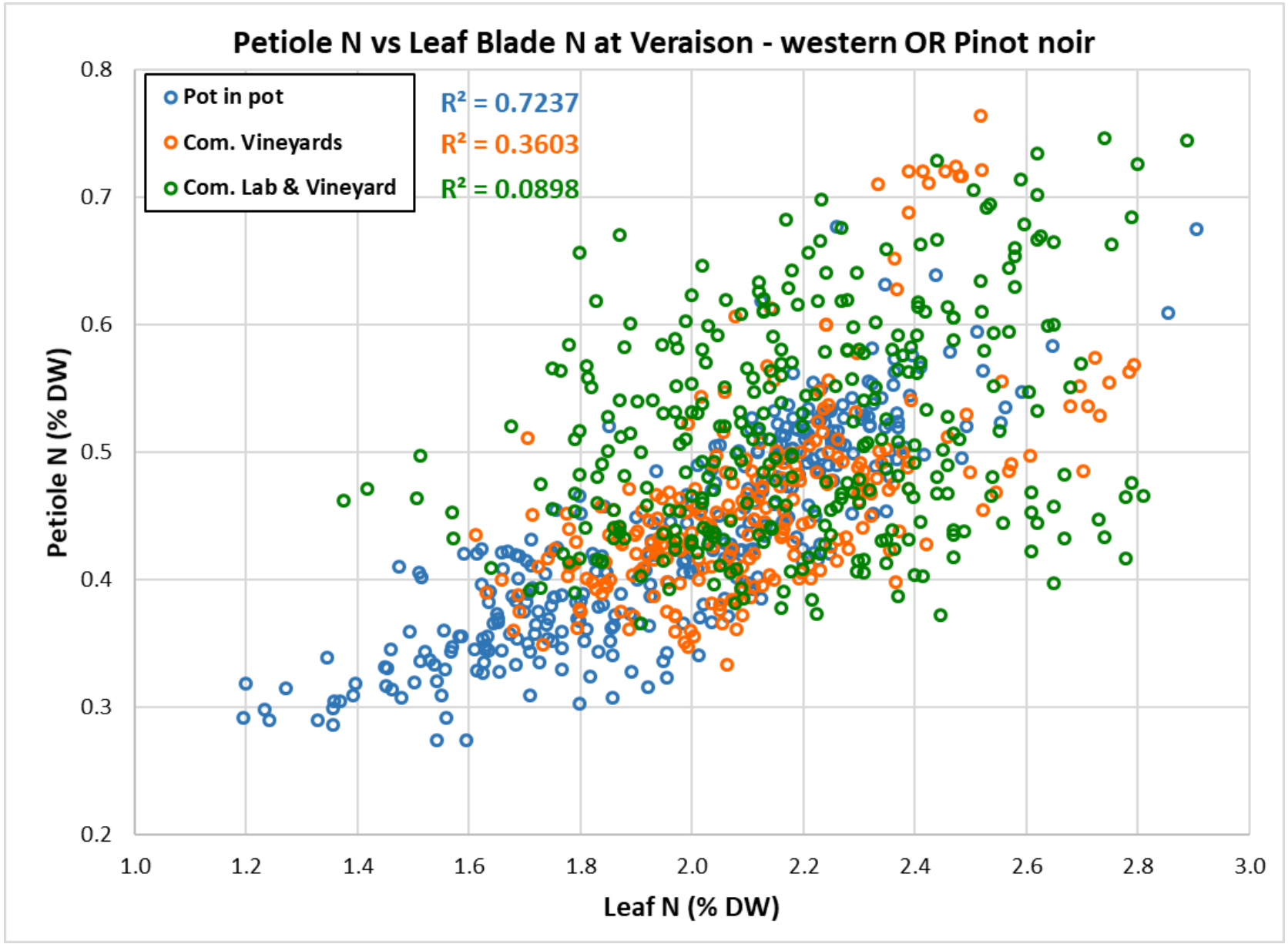
Care & Consistency = Better Nutrient Test Data



Care & Consistency = Better Nutrient Test Data



Care & Consistency = Better Nutrient Test Data



Conclusions:

- Nutrient Data is only as good as the care & effort you place on careful sample collection & analysis
- **Greatest Value – Consistent Annual Data over YEARS!**
- **Leaf blades outperform petioles - beg colleagues to test further**
- **Critical or Optimal Values requires Massive Effort**
- **Other Factors often screw it up (rootstocks / human error / weather)**

Finding Peace in Viticulture Research - Is this a pipe dream ?