Manage vine nutrition in wine grapes

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Why do we care about vine nutrition needs?

- Maintain vine healthy growth
- Achieve production goals (yield and fruit quality)
- Guide fertilization management
- Comply with state and federal regulations

Manage vine nutrition ≠ simply fertilization

Compared with other crops, grapevines have rather modest nutrient requirement

Manage vine nutrition = Integrated program

Vineyard condition
(e.g. variety, rootstock, soil, variability)

Vineyard setting
(e.g. minimum irrigation block)

Vine nutrient status
(tissue testing)

Irrigation and canopy management practices

Cover crop and floor management

Expectations on yield and fruit quality

Any specific concerns from previous year
(e.g. leaf symptoms, winemaker concerns)

Topics covered today

1. Using soil and leaf nutrient test to guide fertilization
2. Recommendations on methods for soil and leaf sampling;
3. Vine nutrient demand and uptake
4. Fertilization

Soil vs leaf tissue nutrient tests: Which one should I choose to understand vine nutrition requirement?

Do soil fertility correlate with vine nutrient status?

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 - 69	0.23 - 0.52	0.138
K	14 - 484	0.90 - 1.48	0.270
Ca	260 - 3680	0.77 - 3.60	0.323
Mg	49 - 1154	0.21 - 0.36	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

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

Soil vs leaf tissue tests

	Soil test	**Leaf tissue test**
Reliability	Not reliable (soil is heterogeneous)	Relatively reliable with consistent sampling protocol
Correlation with growth parameter	Poor	Moderate
Effect of lab protocol on results	Large	Moderate
Difficulty involved in sampling	Large	Low
Lab analysis cost	High	Moderate

Soil Nutrient Test

	Tips on soil nutrient testing
Timing of tests	• pre-planting • annual or bi annual check up
Sampling	• Sample from the same area. 2 to 3 feet below the surface (root system concentrates mainly in the top 50 cm of the soil).
Parameters to test	• Soil texture and pH • Cation exchange capacity (CEC) • Organic matter • Mineral N (ammonium and nitrate) • Salinity (Na, B, and Cl) • Available P, K, Ca, Mg
Purpose	• Determine need of lime or soil acidification based on pH before planting • Troubleshooting after planting

Leaf tissue test

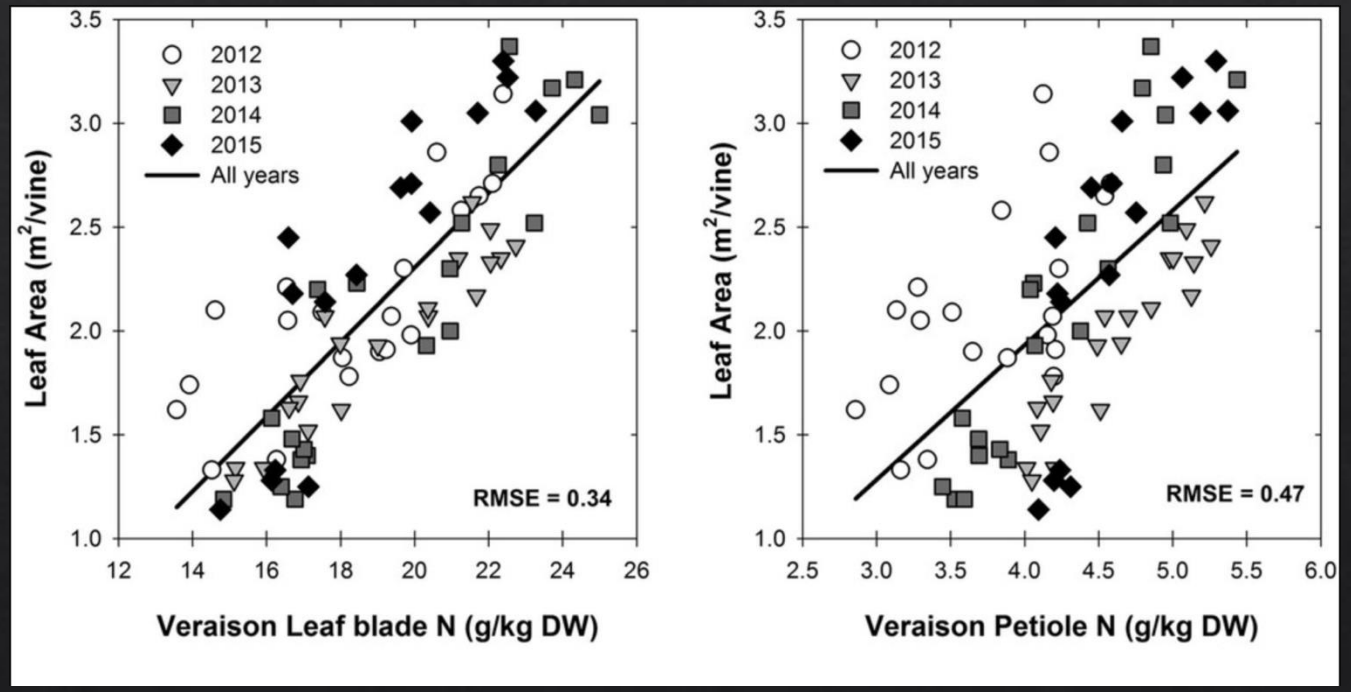
	Tips on leaf tissue testing
Timing of tests	• Bloom, 60 – 70% cap fall (more for micronutrients) • Verasion, 50% color change or soft berries (more for macronutrients
Sample size	• Petioles: 60 – 100 per sample • Leaf blades: 20 – 40 per sample
Sampling protocol	• Sample from same rows/area or same vine every year • Sample same phenological stage • Submit separate samples for weak or problematic areas (different fertilization programs may be necessary)
Parameters to test	• Total N (or nitrate), P, K, Ca, Mg, S, B, Zn, Fe, Mn

Leaf tissue…..petioles or leaf blades?

In studies, leaf blade N at bloom and veraison better correlated with growth parameters, yield and must YAN

Found higher r^2 for leaf BLADES compared to petioles when using regression models

Table adapted from Schreiner & Scagel 2017	r^2 -leaf blade	r^2 - petiole
Leaf Area - Bloom	0.69	0.44
Leaf Area - Verasion	0.68	0.41
Pruning Mass - Bloom	0.68	0.35
Pruning Mass - Verasion	0.73	0.40
Yield - Bloom	0.48	0.24
Yield - Verasion	0.62	0.32
Must YAN - Bloom	0.64	0.31
Must YAN - Verasion	0.74	0.35



Four year of data from pot-in-pot trial.

Schreiner and Scagel. 2017. Leaf Blade versus Petiole Nutrient Tests as Predictors of Nitrogen, Phosphorus, and Potassium Status of 'Pinot Noir' Grapevines

Comparing petiole and leaf blade sampling

	Sampling petioles	Sampling leaf blades
Sample coverage	Lower weight and so more leaves can be covered in one sample	Overcoming the limitation: use a hole puncher for sampling
Process	Easy to wash and dry	
Consistence	Larger year-to-year variability (conduits for nutrients transport; not involved in primary metabolism)	
Ability to guide N and Mg fertilization		Better
Ability to guide P and K fertilization		Similar

More comparison between leaf blade and petiole is needed for other nutrients, such as Mg, Ca, and B. We are working on that!

Soil and leaf tissue sampling

Consistency is the key!

Leaf tissue sampling

- Bloom

  Opposite cluster leaves or leaves on the node above or below clusters

- Veraison

  Sample in pair – one opposite cluster leaf + one newly expanded leaf from the same shoot

Tissues need to be washed before drying and testing!

Interpret nutrient test results

Need more than the lab test results!

Vine Nutrient Guideline

for Oregon wine grape vineyards

Nutrient	Sample timing	Units	Deficient (petiole)	Excessive (petiole)	Deficient (blade)	Safe/Healthy (blade)	Excessive (blade)
N	bloom	%	0.60 - 0.70	N/A	2.2	> 2.40	4.25
N	véraison	%	0.35 - 0.40	N/A	1.8	> 2.00	2.5
P	bloom	%	0.15	N/A	0.17	> 0.20	N/A
P	véraison	%	0.05	N/A	0.1	> 0.12	N/A
K	bloom	%	0.75 - 1.50	3.25	0.7	> 0.80	1.5
K	véraison	%	0.50 - 0.60	N/A	0.6	> 0.70	1.25
Ca	bloom/véraison	%	0.9 - 1.0	N/A	0.9 - 1.0	> 1.00	N/A
Mg	bloom/véraison	%	0.20 – 0.50	N/A	0.10 – 0.20	> 0.25	N/A
Mn	bloom/véraison	ppm	20	N/A	20	> 20	N/A
Zn	bloom/véraison	ppm	20 - 25	N/A	15 - 20	> 20	N/A
B	bloom/véraison	ppm	20 - 25	125	15 - 20	> 20	250
Cu	bloom/véraison	ppm	5-Mar	25 - 50	5-Mar	> 5	N/A

Data shown are based on nutrition research for wine grapes in Oregon with comparison to other regions. *Source: Paul Schreiner, USDA-ARS, Hort Crops Research Lab, Corvallis, OR.*

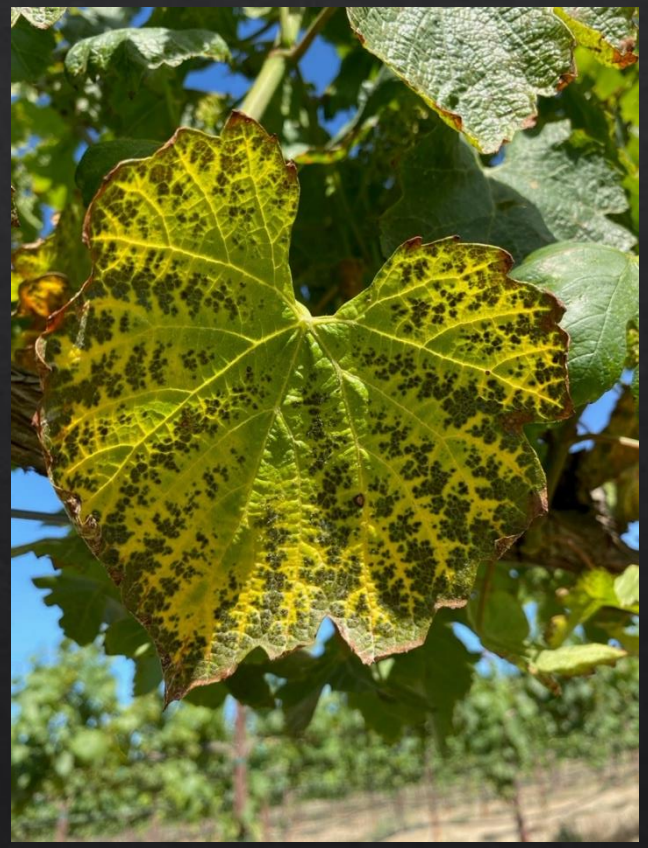
Nutrient guidelines should only be used as reference. The guideline is not customized for individual vineyards

How about using pictures and online info for diagnosing nutrient issues?

Case # 1: Leaf marginal burn

Vineyard condition

- A three-year-old Flame vineyard in the San Joaquin Valley, CA
- Soil is sandy loam
- Vines are stunted and leaves are small
- Vines lost all basal leaves by September. Marginal burn was observed in remaining leaves
- Well water is not sufficient to irrigate the entire 15 acres
- Growers want to use fertilization to correct the problem



Marginal burned leaf for reference. Not from the problematic site

1. What can be the issue? Please choose from the blow

A. Mg deficiency

B. Salinity issue

C. Red blotch infection

Soil Test Result

	% SP	pH	EC dS/m	meq/L Ca	Mg	Na	K	mg/L Cl	B	SO_4S	SAR	QUANT $CaCO_3$ Equiv	LIME PRESENCE LP	Extracted Nutrients mg/kg NO_3N	PO_4P	K AA	Zn	Mn	Fe	Cu
				Soil Solution Constituents																
1. Newmarkle Soil	41	6.6	9.28	67.0	20.7	9.3	2.1	16.0	0.5	153	1.4	<0.10	-	376.2	27.5	312	0.8	26.7	10.9	0.8
OPTIMUM RANGES		6.0-7.5	<4.00 >0.60	Ca > 2x Mg & Na			>0.4	<10	>0.2 <1.5	>50 <400	<5	<2.0% <4.0%		<20.0	>25.0	>150	>2.0	>5.0	>8.0	>1.0

	AMMONIUM ACETATE EXTRACTED CATIONS (ppm - %) Calcium mg/kg	Calcium %CEC	Magnesium mg/kg	Magnesium %CEC	Sodium mg/kg	Sodium %CEC	Potassium mg/kg	Potassium %CEC	Hydrogen mg/kg	Hydrogen %CEC	C.E.C. meq/100g Summation	SPe Cation Total (mg/L)	SPe Soluble Cations Ca %SPe	Mg %SPe	Na %SPe	K %SPe
1. Newmarkle Soil	2880	73.2	452	19.1	81	2.6	312	4.1	2	1.0	19.7	1883	71.2	13.2	11.3	4.3
DESIRED RANGES		>70%	100	10-20%	<150	<5.0%		>4.0%					>60%		<20%	>7%

RED = LOW BLUE = HIGH DOMINANT SOLUBLE SALT IS UNDERLINED. SEE ENCLOSED INTERPRETATION GUIDES. mg/L = ppm mg/kg = ppm

IF YOU SHOULD HAVE ANY QUESTIONS, PLEASE CALL. THANK YOU.

EC = cation exchange capacity = measure of soluble salt concentration

Na, Cl and B = indication of soil salinity

Suitability for vineyard

Problems and unit of measurements	No problem (<10% yield loss)*	Increasing problem (10 - 25 % yield loss)	Severe problems (25 - 50% yied loss)
Salinity EC (dS/m)	**1.5 - 2.5**	**2.5 - 4.0**	**4.0 - 7.0**
Permeability ESP (est)	<10	10.0 - 15.0	>15
Sodium (meq/L)	N/A	>30	N/A
Sodium (ppm)	N/A	>690	N/A
Chloride (meq/L)	**<10**	**10.0 - 30.0**	**>30**
Chloride (ppm)	<350	350 - 1,060	>1,060
Boron (ppm)	**<1**	**1.0 - 3.0**	**>3**
pH	5.5 - 8.5	N/A	N/A

*Note: Guidelines are flexible and should be modified by rootstock choices, local practices, experience, special conditions and method of irrigation. Interpretations are based on chemical analysis of the soil saturation extracts from soil samples representing the top 2 to 3 feet of soil.

Source: Zhuang and Fidelibus, 2023, Vit tips newsletter

Irrigation water test

Analytes				Normal Values	Problem Values
pH (pH)		8.7	pH units	6.5 to 8.0	<6.5 or >8.0
Electrical Conductivity (EC)		0.87	dS/m	0.5 to 3.0	<0.5 or >3.0
Boron (B)		7.72	mg/L	<0.5	>0.5
Cations	**mg/L**	**meq/L**	**lbs/ac-ft**	**Normal Values mg/L**	**Problem Values mg/L**
Calcium (Ca)	2.0	0.10	5.5	30 to 400	<30
Magnesium (Mg)	0.8	0.07	2.3	1 to 60	[Mg]>[Ca]
Sodium (Na)	184	8.02	498	<70	>70
Potassium (K)	0.8	0.02	2.3		
Anions	**mg/L**	**meq/L**	**lbs/ac-ft**	**Normal Values mg/L**	**Problem Values mg/L**
Bicarbonate (HCO_3)	121	1.99	328	<150	>300
Chloride (Cl)	82.2	2.32	222	<150	>200
Nitrate - Nitrogen (NO_3-N)	1.2	0.08	3.1	<10	>10
Sulfate - Sulfur (SO_4-S)	110	3.43	296		
Calculated Values				**Normal Values**	**Problem Values**
Total Dissolved Solids (TDS)		599	mg/L	1 to 1,500	>1,900
Sodium Absorption Ratio (SAR)		27.5		<6.0	>6.0
SAR/EC Ratio (SEC)		31.6		<5.0	>10.0
pHc (pHc)		9.1		<8.4 may add Ca	>8.4 may remove Ca
Gypsum Requirements	**100% gypsum equivalent (lbs/ac-ft)**				
Eatons Gypsum Requirement (EGR)		1160			
Residual Sodium Carbonate (RSC)		426			

2. What can be the issue? Please choose from the blow

A. Mg deficiency

B. Salinity issue

C. Red blotch infection

ANSWER: B

Possible solutions

- Use good quality water to leach down the salts
- Use gypsum to free up sodium, making it easy for leaching. However, this approach should not be taken until late in the season. Otherwise, free Na can hurt the root system and leads to further damage
- If the salinity issue remains unresolved, vines would like continue to decline. Cotton or pistachio can be alternative crop if growing at smaller acreage

Case # 2: leaf marginal burn

Leaves with marginal burn

Pinot noir vineyard in Willamette Valley, OR

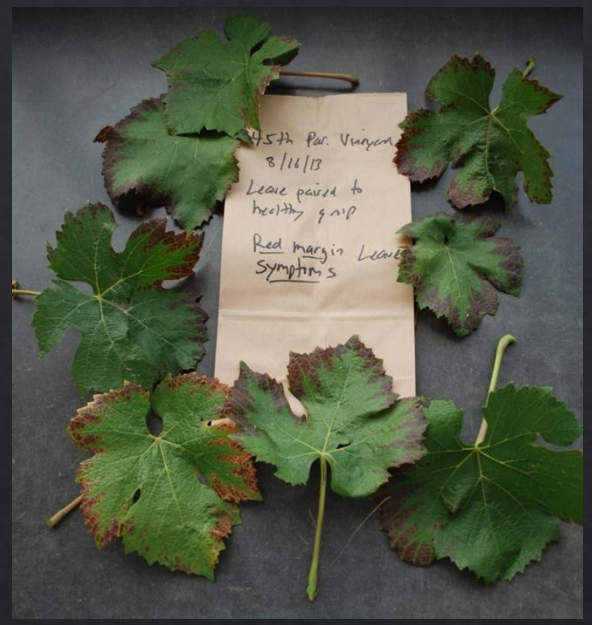
3. What can be the issue? Please choose from the blow

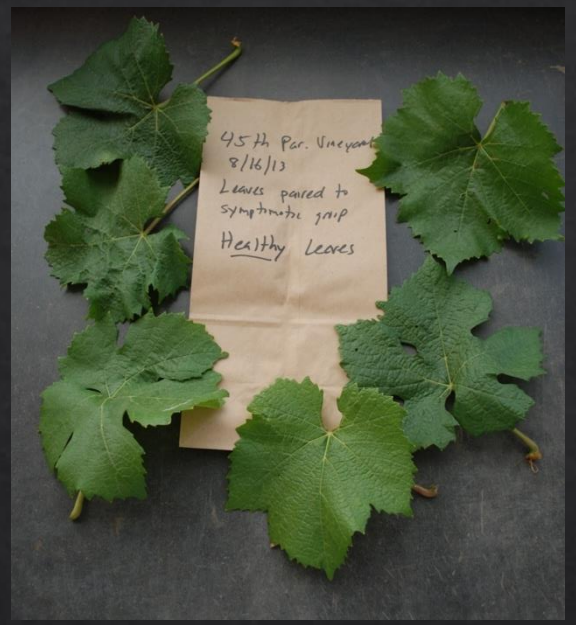
A. Mg deficiency

B. P deficiency

C. Red blotch infection

Paired Sampling to Diagnose Red Leaf Symptoms





	Symtpomatic leaves	Asymptomatic leaves
Leaf Magnesium (%)	**0.08%**	**0.16%**
Leaf Phosphorus (%)	0.20%	0.19%
Petiole Magnesium (%)	0.20%	0.19%

4. What can be the issue? Please choose from the blow

A. Mg deficiency

B. P deficiency

C. Red blotch infection

ANSWER: A

Mg fertilization

- Apply Mg to the canopy or the soil between bud break and veraison to correct the deficiency (caution: $MgSO_4$ should be used with caution as approach to harvest)
- Marginal Mg deficiency should not compromise yield or fruit quality
- While severe deficiency could lead to discoloration in leaves and increase sunburn in fruit

Diagnosis of nutrition related problems requires more than pictures.

Proper tests provides valuable info.

Picture credit to Sarah Andersen

Now, how to fertilize?

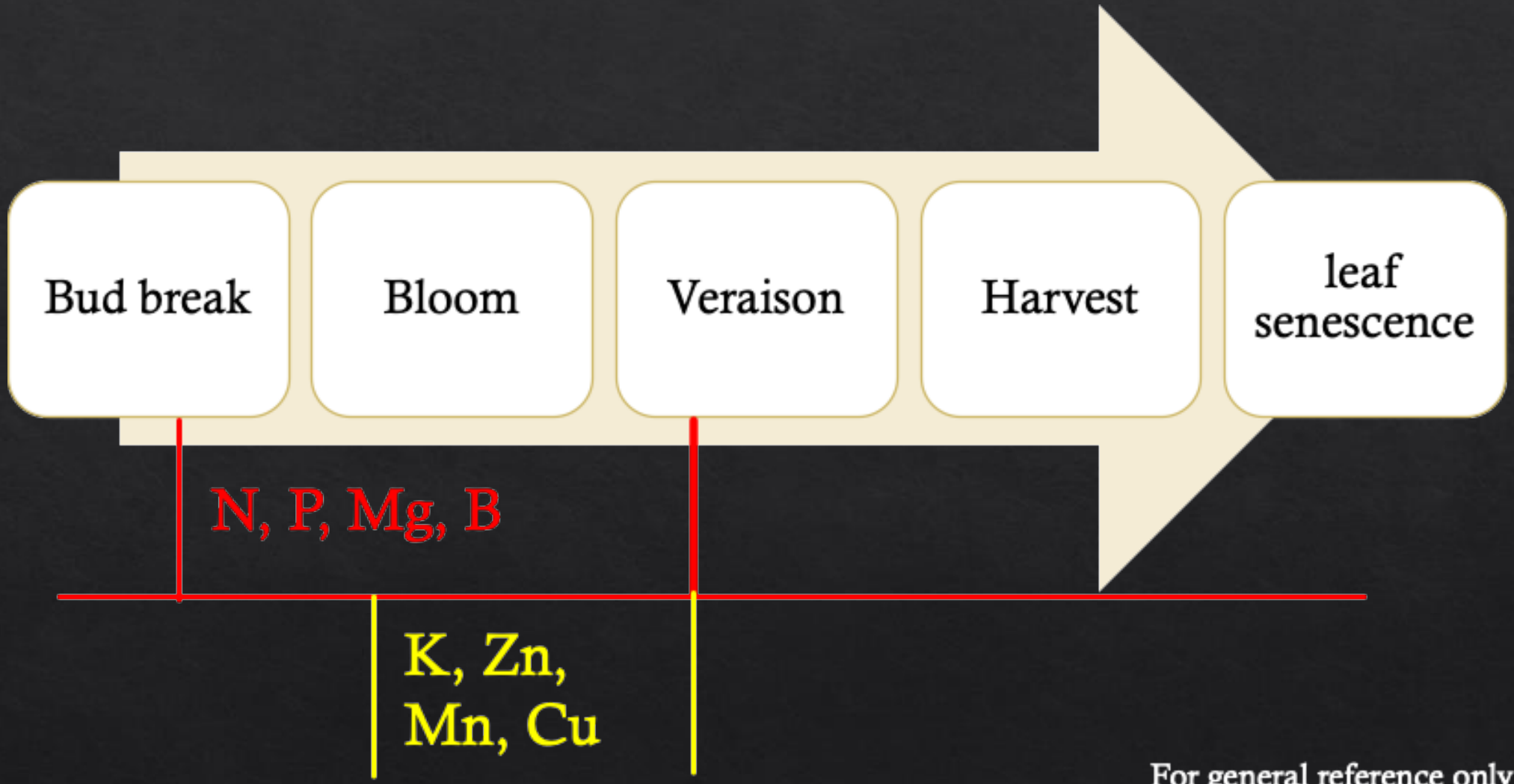
Purpose of Fertilization

- Correct nutrient deficiency
- Compensation nutrient loss during harvest
- Improve vine growth
- Manage yield
- Enhance fruit quality

Vine nutrient demand

- Mature vines requires more nutrients than young vines, due to great annual growth and higher yield
- Vines tend to have higher nutrient demand early in the season than late in the season
- Nutrients are allocated to the canopy (shoots, leaves, and fruit) mainly during bud break to veraison
- Veraison leaf blade and petiole tests are good indicator of N, P, and K

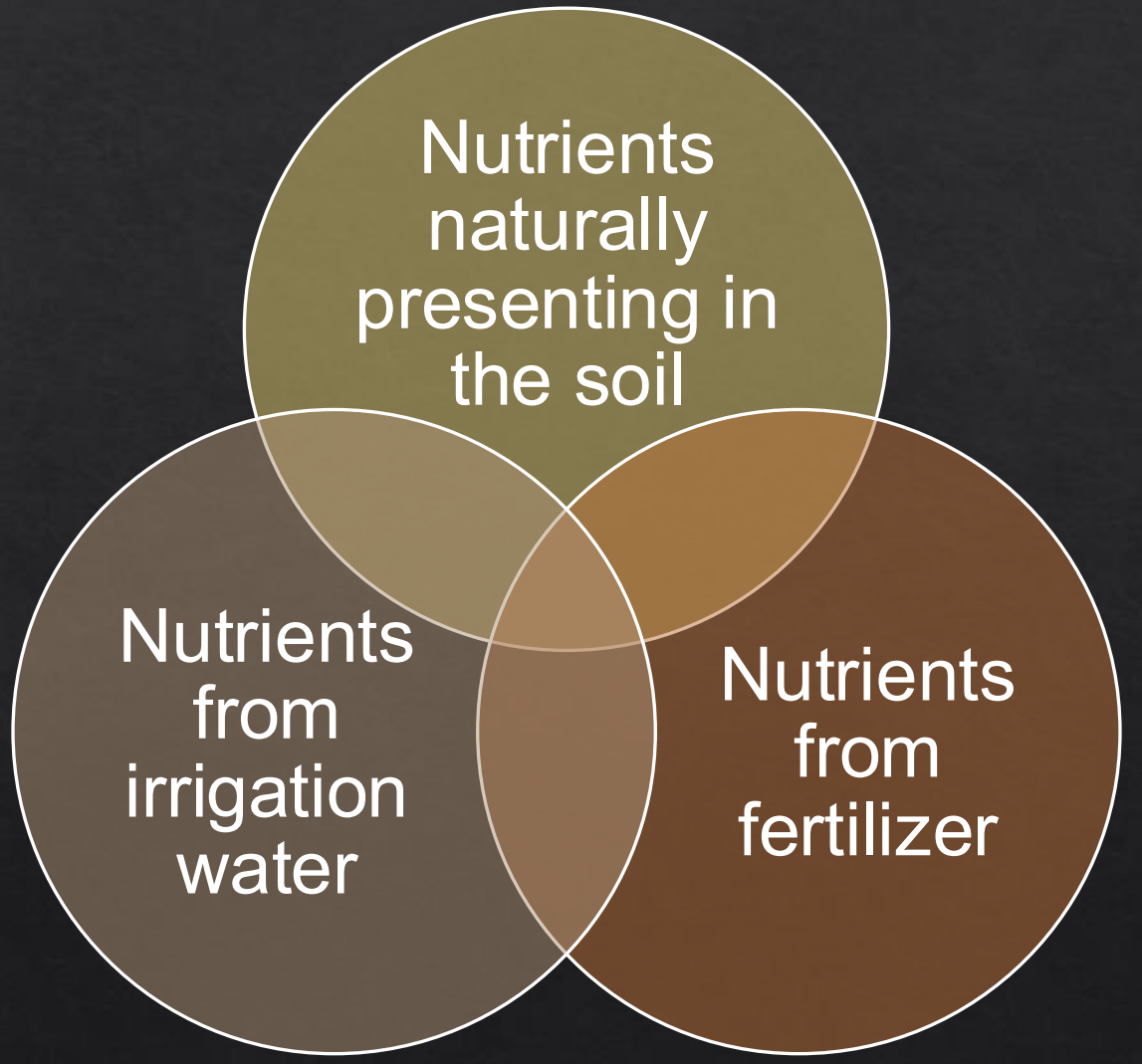
Timing of fertilization



For general reference only

How much to fertilize?

Sources of nutrients



Nutrient acquisition: from soil or reserve?

Summary of calculated nutrient uptake and distribution for Pinot noir grapevines between budbreak and harvest in 2001

Nutrient	Canopy Demand (kg/ha)	Uptake from soil (kg/ha)	Remobilization from reserves (kg/ha)
N	32.4	16.9	15.6
P	3.66	2.88	0.78
K	35.8	33.3	2.5
Ca	25.8	23.1	2.76
MG	9.4	8.42	0.98

Summary of calculated nutrient uptake and distribution for Pinot noir grapevines between budbreak and harvest in 2002

Nutrient	Canopy Demand (kg/ha)	Uptake from soil (kg/ha)	Remobilization from reserves (kg/ha)
N	39.5	17.7	21.8
P	4.1	2.14	1.96
K	39.1	33.4	5.76
Ca	25.1	24.1	0.96
MG	11.8	12.1	0

Adapted from Schreiner and Scagel 2006

Estimated nutrient loss (lb/acre) during harvest and leaf fall

Nutrients	Yield @ 5 tons/acre	Yield @ 6 tons/acre	Yield @ 7 tons/acre	Yield @ 8 tons/acre
N	20	23	26	29
P	3.2	3.8	4.4	4.9
K	28	33	38	43
Ca	3	3.6	4.2	4.8
Mg	3.7	3.9	4.1	4.3

Summary

- **Soil vs leaf:** leaf tissue test offers better reference for vine nutrition needs
- **Leaf blade vs petiole:** Levels from leaf blades are more reliable than petioles for diagnosing N and Mg. Two measures have similar performance on understanding vine P and K.
- **Bloom vs veraison:** Veraison samples are more reliable than bloom samples for diagnosing most nutrients.
- Keep sampling protocols consistent
- History of nutrient testing, record of fertilization, and results from proper test are valuable for trouble shooting and planning

Summary Continued

Fertilization timing

- For majority of the nutrients, peak of uptake occurs between bud break and veraison.
- Fertilization right at bud break may not be efficient, due to the lack of canopy.
- Start the program when the shoots are about 3 to 4 feet tall
- The efficacy of post-harvest fertilization depends on type of nutrient supplied, vine current nutrient status, and weather conditions.

Fertilization amount

- Nutrient loss occurs during pruning, harvest, and leaf fall. Fertilizer applied would compensate for the loss if certain nutrients in the soil are limited
- Nutrients presenting in the soil ≠ 100% taken by vines
- Nutrient reserve varies between nutrients

Thanks a bunch!

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