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Application Note

Nutrients in Grapes and Grape Leaves

Introduction

Measuring leaf and fruit sap ions with meters such as the HORIBA LAQUAtwin is extremely important for grape production.

Sap measurements provide a snapshot of the actual nutrients moving within the vine, not just what is present in the soil. Soil tests alone are insufficient because nutrient availability in vineyards changes continuously due to irrigation management, crop load, canopy growth, weather conditions, and root activity.

The LAQUAtwin meters can measure K^+, NO_3^-, Ca^{2+}, Na^+, pH, and EC in berries, leaves, soil, irrigation water, and fertigation solutions.

Why Ion, pH, and EC Meters Are Essential for Vineyards

Modern grape production is no longer limited by fertilizer availability, but by nutrient balance, timing, and plant uptake efficiency.

Problems such as: excessive vegetative vigor, poor fruit set, uneven berry sizing, soft berries, high juice pH, poor color development, reduced wine quality and weak storage performance in table grapes are most often caused by nutrient imbalances during the growing season rather than deficiencies detected at harvest.
Real-time ion monitoring allows growers to manage nutrition dynamically instead of reactively.

Why ion measurements matter

Ion-specific measurements provide direct insight into what the vine is actively transporting. Unlike soil or laboratory tissue analysis, sap testing reflects current physiological status.

Key advantages include:

- Early detection of K–Ca imbalance affecting berry firmness and wine stability
- Improved nitrogen management to control canopy vigor
- Optimization of fertigation timing
- Reduced fertilizer waste
- Better prediction of fruit quality and harvest performance

Why pH and EC are equally important

While ion meters show nutrient levels, pH and EC explain nutrient behaviour. pH controls nutrient availability and ion competition. Improper pH can reduce uptake even when nutrients are abundant.

EC (Electrical Conductivity) indicates total salt concentration and osmotic stress. High EC may:

- Reduce water uptake
- Limit calcium transport
- Increase sodium accumulation
- Affect berry composition

Ion data should always be interpreted together with pH and EC measurements.

STEP-BY-STEP PROTOCOL

Grape Leaf Sap (Petiole Sap) — Recommended Method

1 Sampling

When: Morning (8–11 am), avoid drought or heat stress
Which leaves:

- Fully expanded leaves from mid-cane position
- Avoid diseased or shaded leaves

How many: 20–30 leaves per field zone.
Remove the petioles (leaf stems). Leaf blades dilute sap and increase variability.

2 Sap Extraction

Equipment

- Garlic press or handheld sap press
- Clean plastic cup
- Coffee filter or syringe filter (optional)

Procedure

1. Chop petioles into small pieces
2. Press firmly to extract sap
3. Collect ≥0.5 mL total sap

Typical yield: 20 petioles → ~0.5–1.0 mL sap.



3 Dilution (IMPORTANT for grapes)

Grape sap is often concentrated, especially for K^+ and NO_3^-.
Standard dilution (recommended starting point):

Meter	Dilution	
NO_3^-	01 : 5	How to dilute (example 1:10) Take 0.10 mL sap and add 0.90 mL distilled / deionized water. Mix gently. Use disposable pipettes or syringes for accuracy.
K^+	1 : 10	
Ca^{2+}	1 : 10	
Na^+	1 : 5	

STEP-BY-STEP PROTOCOL, Grape Berry Juice

1 Sampling

- 3–5 representative clusters.

2 Juice Extraction

1. Remove berries
2. Crush gently
3. Filter solids
4. Collect clear juice

3 Dilution

- K, Ca: usually 1:5 or 1:10
- NO_3^-, Na^+: usually no dilution required

Measurement

Before mesaurement the instrument must be calibrated.

1. Turn on the meter
2. Rinse the sensor with demineralized or normal tap water and dry carefully with a tissue
3. Place some of the 150ppm solution on the sensor and press the CAL button
4. Rinse the sensor with demineralized or normal tap water and dry carefully with a tissue
5. Place some of the 2000ppm solution on the sensor and press the CAL button
6. Rinse and dry the sensor
7. Place the extracted sap or juice onto the sensor
8. Wait for the reading to stablize (takes a couple of seconds)

EXPECTED VALUES

⚠ These are working ranges, not absolute sufficiency standards. Values vary with: cultivar, rootstock, irrigation, crop load, climate, growth stage

Grape Leaf Petiole Sap (ppm, mg/L)

Status	NO_3^-	K^+	Ca^{2+}	Na^+
Low	<300	<1500	<200	—
Adequate	300–700	1500–3000	200–500	<50
High	700–1200	3000–4500	500–800	50–150
Excessive	>1200	>4500	>800	>150

- Excess nitrogen increases canopy vigor and delays ripening.
- High potassium raises juice pH in wine grapes.
- Calcium supports berry firmness and storage.
- Sodium should remain very low.

Grape Berry Juice (ppm, mg/L)

	Range	Note
NO_3^-	<30	High nitrate undesirable
K^+	800–1200	High values increase wine pH
Ca^{2+}	>30–40	Supports firmness
Na^+	<20	Indicates salinity risk

Fruit Ca is naturally much lower than leaf sap Ca.

Practical, Stage-specific Sap Ranges

Below are practical stage-specific sap ranges tailored for grapes using HORIBA LAQUAtwin meters.
These values are management targets, not laboratory sufficiency standards.

1 Grape Leaf Petiole Sap – Target Ranges by Cultivar Type

Sap testing in grapes is typically done on petioles opposite the cluster at bloom, fruit set, veraison, and pre-harvest.

➢ **Wine Grapes – Moderate Vigor**

Examples: Cabernet Sauvignon, Merlot, Syrah, Tempranillo.

	NO_3^-	K^+	Ca^{2+}	Na^+	Ratio
Pre-Bloom	800–1500	3000–5000	400–800	<50	<8:1
Fruit Set	600–1200	2500–4500	500–900	<50	<7:1
Berry Growth	300–800	2000–4000	600–1100	<50	<5:1
Veraison	<300	1800–3500	700–1200	<50	<4:1

Key Focus:

- Avoid excessive nitrogen (reduces wine quality)
- Manage K to control juice pH
- Maintain Ca for berry firmness and skin strength

➢ **High-Vigor / Irrigated Wine Grapes**

Examples: Chardonnay (vigorous sites), Sauvignon Blanc (irrigated).
Key Focus:

	NO_3^-	K^+	Ca^{2+}	Na^+	Ratio
Pre-Bloom	1000–1800	3500–6000	400–700	<60	<10:1
Fruit Set	800–1500	3000–5000	500–900	<60	<8:1
Veraison	400–900	2500–4500	600–1000	<60	<6:1
Pre-Harvest	<400	2000–3800	700–1200	<60	<5:1

- Prevent excessive canopy growth
- Avoid high berry K (raises must pH)
- Monitor Na in irrigated systems

Table Grapes

Examples: Thompson Seedless, Crimson Seedless, Flame Seedless

	NO_3^-	K^+	Ca^{2+}	Na^+	Ratio
Pre-Bloom	1200–2000	4000–6500	300–600	<70	<12:1
Fruit Set	1000–1800	3500–6000	350–700	<70	<10:1
Berry Sizing	700–1400	3000–5500	400–800	<70	<8:1
Pre-Harvest	<500	2500–4500	500–900	<70	<6:1

Key Focus:

- Strong berry sizing (requires K)
- Maintain Ca for firmness and shelf life
- Avoid excess nitrate causing soft berries

2 Soil Conditions –Tables for Grapes

Values refer to root-zone soil solution or exchangeable soil levels

Soil Nitrate (NO_3^- in soil solution, ppm)

Status	Range	Interpretation
Low	<5	Weak canopy growth
Balanced	5–20	Controlled vigor
High	20–35	Excess vegetative growth
Excessive	>35	Poor fruit quality risk

Soil Potassium (Exchangeable K, mg/kg or ppm)

Status	Sandy Soil	Loam Soil	Clay Soil
Low	<100	<150	<200
Adequate	100–180	150–250	200–350
High	180–250	250–350	350–450
Excessive	>250	>350	>450

⚠ High soil K → High berry K → Increase pH.

Soil Calcium (Exchangeable Ca, mg/kg)

Status	Range	
Low	<1000	Calcium is important for: • Berry firmness • Disease resistance • Skin integrity
Adequate	1000–3000	
High	3000–5000	
Excessive	>5000	

Soil Sodium (Na^+, ppm)

Status	Range	
Safe	<50	High Na: • Competes with K uptake • Raises soil EC • Reduces vine longevity
Moderate Risk	50–100	
High Risk	>100	

Soil pH

pH	Interpretation
<5.0	Acid stress risk
5.5–6.5	Ideal
6.5–7.5	Acceptable
>7.5	Micronutrient lockout (Fe, Zn)
	Optimal target: 6.0–7.0

Soil EC (Electrical Conductivity, mS/cm)

EC	Interpretation	
<1.0	Ideal	Grapevines are moderately salt tolerant, but berry quality declines before yield does.
1.0–2.0	Mild stress possible	
2.0–3.0	Yield reduction likely	
>3.0	Severe salt stress	

3 Integrated Interpretation Guide

If You See…	Likely Cause	Action
High petiole K at veraison	Excess soil K or high EC	Reduce K fertigation
Rising must pH	High berry K	Adjust K supply earlier
Excess sap NO_3^- pre-bloom	Over-fertilization	Reduce N immediately
Low sap Ca at berry sizing	Poor uptake or high EC	Improve irrigation uniformity
Rising sap Na	Salinity issue	Check irrigation water EC
High petiole K at veraison	Excess soil K or high EC	Reduce K fertigation

Key Differences: Wine vs Table Grapes

Parameter	Wine Grapes	Table Grapes
Nitrate Tolerance	Lower	Higher
Potassium Need	Moderate	Higher
Ca Requirement	High (skin strength)	Very high (firmness)
Sodium Sensitivity	Moderate	Higher (postharvest)

Tips for Grapes & Leaves

1 What to Measure

- Leaf Petiole Sap: Best indicator of vine nutrient status during the season.
- Berry Juice: Useful for harvest quality assessment but less reflective of vine physiology

2 Consistency

- Sample at similar times of day and environmental conditions.
- Use consistent leaf positions and vine blocks.

Cultivar Considerations

Nutrient targets may vary depending on grape type:

- Table grapes (e.g., Thompson Seedless, Crimson Seedless, Autumn King) generally require higher potassium and nitrogen early in the season to support berry sizing and canopy growth.
- Red wine cultivars (e.g., Cabernet Sauvignon, Merlot, Syrah) typically benefit from moderate nitrogen levels to avoid excessive vigor and shading, which can reduce color and phenolic development.
- White wine cultivars (e.g., Chardonnay, Sauvignon Blanc, Riesling) are often more sensitive to excessive potassium, which can increase juice pH and reduce wine stability.

- Vigorous rootstocks may show higher sap nitrate and potassium levels even under moderate fertilization programs.

What about pH and EC?

pH and EC are also important, but they serve a slightly different purpose than ion-specific measurements like K^+, Ca^{2+}, NO_3^-, and Na^+.

1 pH (Hydrogen ion concentration). Why it matters:

pH affects nutrient availability. Even if you apply enough Ca or K, if the pH is too high or too low, the plant cannot take it up efficiently. Typical ranges for sap are 5.8 to 6.8pH and for irrigation water 5.5 to 7.0pH.
Extreme pH can cause:

- Reduced uptake of Ca
- Mg availability
- Nutrient imbalances

Takeaway: pH is not an ion itself, but controls how well the plant can use other nutrients.

2 EC (Electrical Conductivity). Why it matters:

EC measures total soluble salts in water or sap.
High EC in water or sap indicates salinity stress, which can:

- Reduces tuber size
- Limits Ca movement
- Increases Na^+ risk

Typical target ranges for leaf sap are 2 to 5 mS/cm (varies by cultivar and growth stage), for irrigation water: <1.0 mS/cm.

Use in practice:

- Monitor EC in irrigation water and sap together to detect salt stress early.
- If EC is high you may need adjustments in the irrigation or fertigation systems.

3 How they complement ion measurements

Parameter	Use	Critical for
K^+, Ca^{2+}, NO_3^-, Na^+	Direct ion status	Quality & disorder prediction
pH	Nutrient availability	Ensures uptake efficiency
EC	Total salts / salinity	Detects salinity stress

In short:

- Always check pH and EC for irrigation water and sap.
- Ion meters + pH + EC = full nutritional picture

Advantages of LAQUAtwin instruments:

The HORIBA LAQUAtwin instruments are uniquely suited to farm use because they combine laboratory-grade ion-selective technology with true field practicality.

Key advantages include:

- Direct sap and tuber juice measurement
- Minimal sample preparation
- Small sample volume required
- Portable and field-ready
- Fast results for same-day decisions
- Ion-specific accuracy
- Enables frequent monitoring during critical growth stages

The practical bottom line

Vineyards that integrate ion, pH, and EC monitoring move from fertilizer-based management to quality-driven nutrient control. This results in:

- Better berry composition
- Controlled must pH
- Improved firmness and shelf life
- Reduced excessive vigor
- Lower salt stress risk
- Improved consistency across blocks

Frequent monitoring is essential because nutrient dynamics change rapidly between bloom, berry development, and harvest.

Disclaimer: The sap value ranges and interpretations presented in this application note are **indicative guidelines only**. Actual optimal values may vary depending on cultivar, rootstock, orchard age, crop load, growth stage, climate, irrigation water quality, and management practices. Sap analysis should be used as a **decision-support tool**, not as a standalone diagnostic method. For critical nutrient management decisions, sap measurements should be interpreted together with visual assessment, soil analysis, irrigation water analysis, and periodic laboratory tissue testing.

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