Nutrients in Mangoes and Mango Leaves

Application Note

Introduction

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

Sap measurements provide a snapshot of the actual nutrients moving in the tree, not just what is present in the soil. Soil tests alone are insufficient because nutrient availability in mango changes rapidly with flowering, fruit set, vegetative flush, irrigation, and environmental stress..

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

Why Ion, pH, and EC Meters Are Essential for Mango Farms

Modern mango production is no longer limited by fertilizer availability, but by nutrient balance, timing, and plant uptake efficiency. Disorders such as poor flowering, excessive vegetative growth, uneven fruit size, internal breakdown, soft fruit, jelly seed, low Brix, and poor shelf life are almost always the result of nutrient imbalances that occur during the growing season—not at harvest.

For this reason, real-time measurement tools—ion, pH, and EC meters—have become essential instruments for professional mango farms.

Why ion measurements matter

Ion-specific measurements (K^+, Ca^{2+}, NO_3^-, Na^+) provide direct insight into what the tree is actually absorbing and transporting at that moment. Unlike soil tests or traditional leaf tissue analysis, sap ion measurements reflect current physiological conditions, allowing growers to detect problems early—often weeks before visual symptoms or irreversible fruit damage occur.

Key advantages include:

- Early identification of K–Ca imbalance, a key driver of soft fruit and internal breakdown
- Improved control of nitrogen-driven vegetative growth versus flowering
- The ability to adjust fertigation and foliar programs proactively
- Reduced waste from unnecessary fertilizer applications

In high-value cultivars such as Kent, Keitt, Tommy Atkins, Ataulfo, and Alphonso, these measurements directly affect export quality and storage performance.

Why pH and EC are equally important

While ion meters show what nutrients are present, pH and EC explain why uptake succeeds or fails.

- pH governs nutrient availability and ion competition at the root and leaf level. Even optimal Ca or K levels are ineffective if pH conditions restrict absorption.
- EC (Electrical Conductivity) provides a rapid indicator of total salt concentration and osmotic stress. Elevated EC reduces water uptake, suppresses calcium movement to fruit, and often precedes sodium-related stress.

Together, pH and EC measurements allow growers to:

- Detect salinity stress early
- Diagnose irrigation and fertigation problems
- Interpret ion readings correctly and avoid misinformed decisions

Without pH and EC context, ion data alone can be misleading.

Preparing Sap from Stone Fruit or Stone Fruit Leaves

Sample Collection

1. Select leaves or fruits
   - For leaves: Choose healthy, fully expanded leaves from similar positions
   - Avoid shaded, diseased, or stressed leaves.

- For fruits: Sample fruit juice rather than sap from vascular tissue. Fruit juice works well for nitrate, potassium, sodium, and calcium measurements.

2. Extract the sap

- Leaves: Use a leaf petiole sap press (like a garlic press) or a small handheld sap press to squeeze out the sap.
- Fruits: Peel and chop fruit. Crush or blend flesh; filter out solids so the meter only contacts clear liquid.
- If needed, dilute samples with deionized or distilled water so that the ion concentration falls inside the calibrated range of the meter.

STEP-BY-STEP PROTOCOL

Mango 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-shoot position
- Avoid diseased or shaded leaves

How many: 20–30 leaves per block or variety
Remove the petioles (leaf stems). The 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 5–10 mm pieces
2. Press firmly to extract sap
3. Collect ≥0.5 mL total sap

Typical yield: 20 petioles → ~0.4–0.8 mL sap.



3 Dilution (IMPORTANT for mango)

Mango sap is usually too concentrated for Ca and K meters.
Standard dilution (recommended starting point):

Meter	Dilution
NO_3^-	1:5
K^+	1:10
Ca^{2+}	1:10
Na^+	1:5

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.

STEP-BY-STEP PROTOCOL

Mango Fruit Juice

1 Sampling

- 3–5 representative mangoes
- Avoid damaged or overripe fruit

2 Juice Extraction

1. Peel and chop fruit
2. Crush or blend
3. Filter solids
4. Collect clear juice

3 Dilution

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

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 typical working ranges, not absolute sufficiency standards. Mango sap varies strongly with:

- Cultivar
- Crop load
- Irrigation
- Weather
- Growth stage

Mango Leaf Petiole Sap (ppm, mg/L)

Status	NO_3^-	K^+	Ca^{2+}	Na^+
Low	<250	<1400	<180	–
Adequate	250–600	1400–2800	180–450	<50
High	600–1000	2800–4200	450–750	50–150
Excessive	>1000	>4200	>750	>150

Mango requires controlled nitrogen to balance flowering and vegetative growth.

High K suppresses Ca movement → soft fruit and internal disorders.

Sodium should remain very low.

Mango Fruit Juice (ppm, mg/L)

	Range	Note
NO_3^-	<30	High nitrate is undesirable
K^+	800–1200	Excess → soft fruit, poor shelf life
Ca^{2+}	>35	Low Ca → jelly seed, breakdown
Na^+	<20	Indicates salinity stress

Note: Fruit Ca is much lower than leaf sap Ca.

Practical, Stage-specific Sap Ranges

Below are practical, stage-specific sap ranges tailored for Mangoes using HORIBA LAQUAtwin NO_3^-, K^+, Ca^{2+}, and Na^+ meters. These are working target ranges designed for orchard decision-making rather than laboratory diagnostics.

Leaf Petiole Sap (ppm, corrected for dilution)
STANDARD MANGO CULTIVARS
Examples: Kent, Keitt, Tommy Atkins, Ataulfo, Alphonso

	NO_3^-	K^+	Ca^{2+}	Na^+
Pre-Flowering	200–400	1800–3000	350–600	<50
Flowering – Fruit Set	250–500	2000–3200	400–650	<50
Early Fruit Growth	300–600	2200–3500	450–700	<50
Mid-Season	250–500	1800–3000	500–750	<50

MANGO FRUIT JUICE TARGETS (AT HARVEST)

	NO_3^-	K^+	Ca^{2+}	Na^+
Desired Range	<30	800–1100	>40	<20
K:Ca ratio		< 20:1		

K : Ca ratio (leaf sap)

The ratio in mango leaf sap is critically important for fruit quality, impacting firmness, size, and preventing disorders like "jelly seed" or internal breakdown, as potassium (K) and calcium (Ca) compete for uptake; optimal ratios ensure proper cell wall strength (Ca) and fruit filling (K).

Stage	Target
Flowering	< 8 : 1
Mid-season	< 6 : 1
Pre-harvest	< 4 : 1

Tips for Mangoes & Leaves

What to Measure

- Leaves (Petiole Sap): Good for rapid assessment of nutrient status (especially nitrate and potassium) during growing season.
- Juice: Suitable for quick quality checks (e.g., potassium or calcium content that might relate to fruit quality), but values may not directly reflect plant physiological status like sap measurements do.

Consistency

- Sample at similar times of day and environmental conditions to reduce variability.

Dilution & Compensation

- If ion concentrations exceed the meter's range, dilute the sample and apply a correction factor. For example, diluted plant sap readings must be multiplied by the dilution ratio

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 mango sap or irrigation water:
Sap: Usually 5.5–6.5
Irrigation / fertigation water: 6.0–7.0

Extreme pH can cause:

- Reduced uptake of Ca, Mg, Fe, Mn
- Nutrient imbalances causing poor flowering and fruit quality

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:

- Reduce water uptake
- Increase Na^+ accumulation
- Interfere with K^+ and Ca^{2+} uptake

Typical target ranges:
Leaf sap EC: 1,0–3,0 mS/cm (varies by growth stage)
Irrigation water: <0.75 mS/cm preferred for Mangoes.
Monitor EC in irrigation water and sap together to detect salt stress early.

3 How they complement ion measurements

Parameter	Use	Critical for
K^+, Ca^{2+}, NO_3^-, Na^+	Direct ion status	Nutrient balance, disorder prediction
pH	Nutrient availability	Ensures applied nutrients can be absorbed
EC	Total salts / salinity	Detects stress, Na^+ interference

In short:
- Always check pH and EC for irrigation water and sap.
- Ion meters + pH/EC = full picture of plant nutrient status and stress risk.

Advantages of LAQUAtwin instruments for mango farms

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

Key advantages include:
- Direct measurement of plant sap and fruit juice with no complex preparation
- Extremely small sample volume requirements, ideal for petiole sap
- Fast, repeatable results that enable same-day management decisions
- Ion-specific accuracy, allowing precise tracking of K, Ca, NO_3^-, and Na
- Portable, durable design suitable for orchard and packhouse environments
- Proven reliability across agriculture, research, and advisory services worldwide

Importantly, LAQUAtwin meters make frequent monitoring realistic, which is critical because nutrient dynamics change rapidly during post-bloom, fruit expansion, and pre-harvest stages.

The practical bottom line
Mango farms that integrate ion, pH, and EC monitoring move from calendar-based fertilization to data-driven nutrient management.

This leads to:
- Better fruit quality and consistency
- Improved storage performance
- Lower input costs
- Reduced environmental impact
- Greater confidence in management decisions

In today's high-cost, high-risk mango production systems, ion, pH, and EC meters are no longer optional diagnostic tools—they are essential management instruments. The LAQUAtwin platform makes this level of precision practical, affordable, and actionable for modern mango growers.

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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