



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-L404

Soil Nitrate Quick Test – Test Strip Method

Standard Operating Procedure

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1. Purpose

This procedure describes a rapid, semi-quantitative field or laboratory method for estimating soil nitrate (NO_3^-) concentration using colorimetric test strips in a calcium chloride (CaCl_2) extracting solution (Bronikowski & Thomason, 2022; Hartz, 2010). The method is useful as a screening tool for assessing soil nitrogen status, guiding fertilizer decisions, and identifying spatial patterns in nitrate availability across a site (Magdoff et al., 1984). It is not a substitute for the quantitative KCl extraction and colorimetric analysis described in [SOP-L403](#) (Mulvaney, 1996), but provides rapid, low-cost results that can be obtained in the field or with minimal laboratory equipment.

2. Scope

- **Applies to:** Rapid estimation of soil nitrate in field-moist or air-dried mineral soils from all EA Program sites; on-site field screening during sampling campaigns
- **Does not apply to:** Quantitative reporting of soil nitrate for publication (use [SOP-L403](#)); ammonium determination (test strips do not measure NH_4^+); water sample nitrate (use [SOP-L303 Hach Colorimetric](#))
- **Location:** Field sites or EA Program laboratory, SGM 133

3. Responsibilities

Role	Responsibility
Lab PI	Approve SOP, ensure training compliance
Field Lead	Coordinate field testing logistics
Trained Personnel	Perform tests, record and report results
New Students	Complete training before independent use

4. Definitions

- **Calcium chloride (CaCl_2) extractant:** A dilute salt solution (approximately 0.01 M) used in the quick test to displace some exchangeable NO_3^- from soil without requiring the high-ionic-strength KCl used in quantitative extractions; minimizes matrix effects on the test strip reaction.
- **Colorimetric test strip:** A plastic strip impregnated with reagents that react with nitrate (or another target) to produce a visible color change; read visually against a printed color chart or with a reflectometer; semi-quantitative.
- **Detection range:** The span of concentrations over which a test strip or method produces a distinguishable response; for most nitrate strips, approximately 0–500 mg NO_3^- -N L^{-1} in the extract; values outside this range require dilution or a quantitative method.
- **Matrix effect:** Interference from sample components (chloride, organic matter, pH) that alter the test strip reaction; minimized by using CaCl_2 extractant and diluting dark or strongly colored samples.

- **Semi-quantitative:** A measurement that provides an approximate concentration within broad categories (e.g., 0, 10, 25, 50, 100 mg/L) rather than a precise numerical value; appropriate for screening but not for publication or regulatory reporting.

5. Safety and Hazards

Hazards

- **Chemical:** Calcium chloride (CaCl_2) is a mild irritant to skin and eyes. The extracting solution is dilute (approximately 0.01 M) and poses minimal risk.
- **Biological:** Soil may contain pathogens. Wash hands after handling.

5.1. Required PPE

- ☐ Nitrile gloves
- ☐ Safety glasses
- ☐ Closed-toed shoes (if testing in the field)

5.2. Emergency Procedures

For CaCl_2 solution contact with eyes, flush with water for 15 minutes. Refer to [SOP-L002 Laboratory Safety](#).

6. Equipment and Materials

6.1. Equipment

Item	Notes
Graduated centrifuge tubes (50 mL, e.g., Falcon tubes)	With volume markings at 30 and 40 mL
1-gallon jug or carboy	For preparing CaCl_2 extracting solution
Soil probe or auger	For field sampling
Bucket	For compositing and mixing field samples
Timer or watch	For tracking settling and reading times
Field notebook	For recording results

6.2. Consumables

Item	Notes
Nitrate test strips	Semi-quantitative colorimetric strips (e.g., Hach, EM Quant, or equivalent)
Calcium chloride (CaCl_2), anhydrous or dihydrate	For preparing extracting solution
Distilled or deionized water	For preparing extracting solution
Color comparison chart	Provided with test strips

7. Procedure

7.1. Preparing the Extracting Solution

1. Add 6 g (approximately 1 teaspoon) of anhydrous CaCl_2 to 1 gallon (3.78 L) of distilled water
2. Cap and shake until dissolved
3. This produces approximately 0.014 M CaCl_2 , sufficient for approximately 125 tests
4. Label the container with the reagent name, concentration, and preparation date
5. Store at room temperature. The solution is stable indefinitely.

Note

CaCl_2 is used instead of plain water because the calcium ions displace nitrate from soil exchange sites, giving a more complete extraction (Gelderman & Beegle, 2015; Houba et al., 1986). The low concentration avoids interference with the test strip chemistry.

7.2. Collecting the Soil Sample

1. Collect soil from the target depth (typically 0–15 cm or 0–30 cm) using a probe or auger per [SOP-F400 Soil Sampling](#)
2. Composite multiple subsamples if a plot-level estimate is desired
3. Homogenize the soil in a bucket by hand-mixing
4. Remove visible roots and stones

7.3. Performing the Quick Test

1. Fill a graduated centrifuge tube with 30 mL of the CaCl_2 extracting solution
2. Add soil to the tube until the total volume reaches the 40 mL mark (approximately 10 mL of soil displaced)
3. Cap the tube securely
4. Shake vigorously until all soil is well mixed (approximately 30 seconds)
5. Allow the tube to stand upright for the soil particles to settle. Wait at least 10 minutes but no more than 1 hour.
6. Dip a nitrate test strip into the clearer supernatant near the top of the tube for 1 second. Do not stir up settled soil.

7. Remove the strip and hold horizontally
8. Compare the strip to the manufacturer's color chart at both 30 seconds and 60 seconds after dipping
9. Record the nitrate reading (ppm NO_3^- -N or ppm NO_3^- , depending on the strip brand) and the reading time used

! Important

Read the strip at the times specified by the manufacturer. Reading too early or too late gives inaccurate results. If the strip brand reports in ppm NO_3^- , divide by 4.43 to convert to ppm NO_3^- -N.

7.4. Applying the Soil Texture Correction Factor

The test strip reads the nitrate concentration in the extract solution, not in the soil. To estimate the nitrate concentration in the soil itself, apply a correction factor based on soil texture and moisture status (Gelderman & Beegle, 2015):

Texture	Moist Soil Factor	Dry Soil Factor
Sand	2.3	2.6
Loam	2.0	2.5
Clay	1.7	2.2

$$\text{Soil NO}_3^- \text{-N (ppm)} = \text{Strip reading (ppm)} \times \text{Correction factor}$$

Determine the soil texture using [SOP-F401 Texture by Feel](#) or [SOP-L401 Hydrometer](#).

7.5. Recording Results

Record the following in the field notebook or data sheet for each test:

- Date, time, site, plot ID
- Sampling depth (cm)
- Soil condition (moist or dry)
- Estimated texture (sand, loam, or clay)
- Strip reading (ppm) and reading time (30 s or 60 s)
- Correction factor applied
- Corrected soil NO_3^- -N (ppm)

8. Quality Control and Acceptance Criteria

8.1. Limitations

The test strip method is semi-quantitative. Results should be interpreted as approximate categories (low, moderate, high) rather than precise concentrations (Hartz, 2010; Schmidhalter, 2005). Key limitations include:

- Strip resolution is typically 10–25 ppm increments; fine differences are not detectable
- Color matching is subjective (ambient lighting affects perception)
- The method does not measure ammonium (NH_4^+); total inorganic N requires [SOP-L403](#)
- Soil moisture, organic matter, and temperature all influence extraction efficiency

8.2. Interpretation Guide

Corrected Soil NO_3^- -N (ppm)	Interpretation	Agronomic Implication
Less than 10	Low	N likely limiting; fertilization may be warranted
10 – 25	Moderate	Adequate for many crops
25 – 50	High	Sufficient N; reduce or defer applications
Greater than 50	Very high	Excess N; potential leaching risk

These thresholds are general guidelines adapted from Magdoff et al. (1984) and Hartz (2010). Consult crop-specific guidelines and local extension recommendations.

8.3. QC Requirements

- Run a blank (CaCl_2 solution only, no soil) at the start of each testing session. The strip should read 0 ppm or below the lowest detection increment.
- Run a duplicate test on at least 1 in 10 samples. Duplicates should agree within one color-chart increment.
- Verify test strip expiration date before use. Expired strips may give unreliable color development.
- For critical decisions, confirm quick-test results with the quantitative KCl extraction method ([SOP-L403](#))

9. Waste Disposal

Waste Type	Disposal Method
Soil slurry waste	Return to field site or standard trash
CaCl_2 solution	Drain (non-hazardous at this concentration)

Waste Type	Disposal Method
Used test strips	Standard trash
Used centrifuge tubes	Rinse and reuse, or standard trash

10. References

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11. Training Record

Before performing the nitrate quick test independently, personnel must:

1. Read this SOP in full
2. Complete [SOP-F001 Field Safety](#) training (if testing in the field) or [SOP-L002 Laboratory Safety](#) (if in the lab)
3. Prepare the CaCl_2 extracting solution under supervision
4. Perform at least three practice tests with acceptable blank and duplicate results
5. Demonstrate correct use of the color chart and correction factor
6. Be signed off by the PI, field lead, or lab manager

12. Appendix A: Example Calculation

```
# Nitrate quick test correction example

strip_reading_ppm <- 15          # ppm NO3-N from test strip
soil_texture <- "loam"
soil_condition <- "moist"       # "moist" or "dry"

# Correction factors
factors <- data.frame(
  texture = c("sand", "loam", "clay"),
  moist = c(2.3, 2.0, 1.7),
  dry = c(2.6, 2.5, 2.2)
)

cf <- factors[factors$texture == soil_texture, soil_condition]

corrected_ppm <- strip_reading_ppm * cf

cat(sprintf("Strip reading:      %d ppm NO3-N\n", strip_reading_ppm))
cat(sprintf("Texture:           %s\n", soil_texture))
cat(sprintf("Condition:          %s\n", soil_condition))
cat(sprintf("Correction factor: %.1f\n", cf))
cat(sprintf("Corrected value:     %.0f ppm NO3-N\n", corrected_ppm))
```