

Zinc in Soils

Turbidimetric determination subsequent photometric determination with pyridylazoresorcinol (PAR) subsequent to acid extraction

Introduction

Zinc is an essential trace element required for plant growth and is involved in numerous biological processes, including enzyme activity and photosynthesis. However, both deficiency and excess of zinc can affect plant performance, and elevated concentrations can disrupt physiological processes and element homeostasis.¹

In soil, zinc typically occurs in the range of 10 to 300 mg/kg, with an average concentration of approximately 50 mg/kg. Zinc availability is influenced by soil properties, and deficiency is commonly observed in sandy, calcareous, saline, and organic matter-rich soils.¹

Zinc contamination in soil is associated with agricultural and industrial inputs, including fertilizer application, industrial effluents, and mining activities. Determination of zinc in soil is therefore required to assess its concentration under varying conditions.

Experimental

This application note details the photometric determination of zinc in soils after its acid extraction.

Method

In alkaline solution zinc ions react with pyridylazoresorcinol (PAR) to form a red complex that is determined photometrically.

Measuring Range

Spectroquant® Zinc Cell Test (1.00861)	Test kit: 0.025–1.000 mg/L Zn
	Method: 0.50–20.00 mg/kg Zn
Spectroquant® Zinc Cell Test (1.14566)	Test kit: 0.20–5.00 mg/L Zn
	Method: 4.0–100 mg/kg Zn

Applicable Sample

Soil samples

Reagents, Instruments and Materials

Test/Reagent Kit(s)

For the measurement the following Spectroquant® test kits is necessary:

- Spectroquant® Zinc Cell Test (**1.00861**)
- Spectroquant® Zinc Cell Test (**1.14566**)

Instrument(s) & Devices

For the measurement one of the following Spectroquant® photometers is necessary:

- Spectroquant® VIS Spectrophotometer Prove 100 plus (**1.73026**)
- Spectroquant® UV/VIS Spectrophotometer Prove 300 plus (**1.73027**)
- Spectroquant® UV/VIS Spectrophotometer Prove 600 plus (**1.73028**)
- Spectroquant® Colorimeter Move 100 (**1.73632**)

Note: Also, legacy Spectroquant® instruments are suitable.

Software for Data Transfer

- Optional Spectroquant® Prove Connect to LIMS software package (**Y.11086**) to transfer your data into an existing LIMS system.

Other Reagents and Accessories

- Hydrochloric acid 25% for analysis (**1.00316**)
- Hydrochloric acid 1 mol/l for analysis (**1.09970**)
- Sodium hydroxide solution 10% for analysis (**1.05588**)
- MQuant® Universal indicator strips pH 0–14 (**1.09535**)
- MQuant® pH-indicator strips pH 0–6 (**1.09531**)

- Water suitable for UV/Vis spectroscopy, EMSURE® (1.16754)
- Analytical balance
- Standard laboratory glassware (e.g., glass beakers) and pipettes
- Shaker or stirring plate
- Sieve
- Spatula
- pH-meter
- Charcoal activated for soil test
- Folded filter

Analytical Procedure

For more information on the measurement see the packaging insert for the test.

Sample Preparation

- In a glass beaker place 10 g of air-dried and sieved (mesh 2 mm) sample with 100 mL hydrochloric acid 1 mol/L and a spatula-tip full of charcoal activated for soil tests and mix well for 1 hour. The pH-value should be 1–2 (check with pH-indicator strips). If necessary, adjust with hydrochloric acid 25%.
- Afterwards adjust the pH-value of the suspension to 3.0 with sodium hydroxide solution 10%, using the pH-meter.
- Then remove the undissolved matter by filtration through a folded filter and wash the filter residues 3 times with water for analysis.
- Collect the filtrate and the washings in a 200 mL standard volumetric flask, finally fill up to volume with water for analysis and mix well.

Using Cat. No. 1.00861: Procedure and Measurement

For more information on the measurement see the packaging insert for the test.

Procedure

- Pipette 10 mL Pretreated sample into a suitable glass vessel.
- Add 1 level grey microspoon (In the cap of the Zn-1K bottle) Reagent Zn-1K and shake until the reagent is dissolved completely: **Sample-reagent mixture**
- **Caution! The reaction cell contains potassium cyanide!**
- Pipette 0.50 mL Reagent Zn-2K into a reaction cell, close the cell tightly, and mix.
- Add 2.0 mL of the **Sample-reagent mixture** with a pipette, close the cell tightly, and mix.
- Add 5 drops Reagent Zn-3K, close the cell tightly, and mix. Hold the bottle vertically when adding the reagent.

- Leave to stand for 15 min (reaction time), then measure the sample in the photometer.

Measurement

- For photometric measurement the cells must be clean. Wipe, if necessary, with a clean dry cloth.
- Measurement of turbid solutions yields false-high readings.
- The pH of the measurement solution must be within the range 9.0–9.2.
- The color of the measurement solution remains stable for at least 60 min after the end of the reaction time stated above.

Hints for Measurement

- It is recommended to zero the method each new working day. To do this, open the method, either by manually selecting the method or by inserting a barcoded cell. Tap the <Settings> button and select the <ZERO ADJUSTMENT> menu item. After prompting, insert the 16 mm zero cell through the corresponding opening. The zero adjustment is performed automatically. Confirm the performance of the zero-adjustment procedure by clicking on <OK>.
- After the zero has been performed, insert the barcoded Spectroquant® round cell through the corresponding opening, ensuring that the white position mark on the cell is aligned with the positioning mark on the spectrophotometer. The measurement starts automatically.
- Read off the result in mg/L from the display.

Hint: The above written measurement description is only valid for the Spectroquant® Prove (plus) series photometer. If a different instrument is used, please consult the corresponding instrument manual for more details on how to perform the measurement.

Using Cat. No. 1.14566: Procedure and Measurement

For more information on the measurement see the packaging insert for the test.

Procedure

- Place 5 drops Reagent Zn-1K into a reaction cell, close the cell tightly, and mix. Hold the bottle vertically when adding the reagent.
- Add 0.50 mL Pretreated sample with a pipette, close the cell tightly, and mix.
- Add 5 drops Reagent Zn-2K, close the cell tightly, and mix. Hold the bottle vertically when adding the reagent. The pH must be within the range of 9.0–10.5. Check with MQuant® pH-indicator strips. Adjust the pH, if necessary, with reagent Zn-1K.

- Leave to stand for 15 min (reaction time), then measure the sample in the photometer.

Notes:

- If the bottle is not held vertically when adding the reagents, the correct drop size and correspondingly the correct amount of reagent and thus the correct pH value will not be achieved.

Measurement

- For photometric measurement the cells must be clean. Wipe, if necessary, with a clean dry cloth.
- Measurement of turbid solutions yields false-high readings.
- The pH of the measurement solution must be within the range 9.0–10.5. If the value is too high, false-low readings are yielded
- The color of the measurement solution remains stable for 3 min after the end of the reaction time stated above. (After 60 min the measurement value would have diminished by 5%.)

Hints for Measurement

- It is recommended to zero the method each new working day. To do this, open the method, either by manually selecting the method or by inserting a barcoded cell. Tap the <Settings> button and select the <ZERO ADJUSTMENT> menu item. After prompting, insert the 16 mm zero cell through the corresponding opening. The zero adjustment is performed automatically. Confirm the performance of the zero-adjustment procedure by clicking on <OK>.
- After the zero has been performed, insert the barcoded Spectroquant® round cell through the corresponding opening, ensuring that the white

position mark on the cell is aligned with the positioning mark on the spectrophotometer. The measurement starts automatically.

- Read off the result in mg/L from the display.

Hint: The above written measurement description is only valid for the Spectroquant® Prove (plus) series photometer. If a different instrument is used, please consult the corresponding instrument manual for more details on how to perform the measurement.

Analytical Quality Assurance

Analytical quality assurance (AQA) is recommended before each measurement series.

To check the photometric measurement system (test reagents, measurement device, handling) and the mode of working, a diluted zinc standard solution containing 2.00 mg/L Zn or Spectroquant® CombiCheck 100 can be used. Besides a standard solution with 0.750 mg/L Zn²⁺, this article also contains an addition solution for determining sample-dependent interferences (matrix effects).

Sample-dependent interferences (matrix effects) can be determined by means of standard addition or dilution.

To view additional notes, visit

[SigmaAldrich.com/qa-test-kits](https://www.sigmaaldrich.com/qa-test-kits).

Calculation

Zinc content in mg/kg Zn = analysis value in mg/L Zn x 20

References

1. Kaur, H.; Srivastava, S.; Goyal, N.; Walia, S. Behavior of Zinc in Soils and Recent Advances on Strategies for Ameliorating Zinc Phytotoxicity. *Environ. Exp. Bot.* **2024**, *220*, 105676. DOI: [10.1016/j.envexpbot.2024.105676](https://doi.org/10.1016/j.envexpbot.2024.105676).

Featured Products

Description	Cat. No.
Test Kits	
Spectroquant® Zinc Cell Test	1.00861
Spectroquant® Zinc Cell Test	1.14566
Instruments & Accessories	
Spectroquant® VIS Spectrophotometer Prove 100 plus	1.73026
Reagents & Test Strips	
Hydrochloric acid 25% for analysis	1.00316
Hydrochloric acid 1 mol/L for analysis	1.09970
Sodium hydroxide solution 10% for analysis	1.05588
MQuant® Universal indicator strips pH 0–14	1.09535
MQuant® pH-indicator strips pH 0–6	1.09531
Water suitable for UV/Vis spectroscopy, EMSURE®	1.16754

Related Products

Description	Cat. No.
Instruments & Software	
Spectroquant® UV/VIS Spectrophotometer Prove 300 plus	1.73027
Spectroquant® UV/VIS Spectrophotometer Prove 600 plus	1.73028
Spectroquant® Colorimeter Move 100	1.73632
Spectroquant® Prove Connect to LIMS software package	Y.11086
Reference Materials	
Spectroquant® CombiCheck 100	1.18701
Zinc standard solution Certipur® 1000 mg/L Zn	1.19806
Reagents, Test Strips, & Accessories	
Nitric acid 65% for analysis EMSURE®	1.00456
Spectroquant® Crack Set 10C	1.14688
Spectroquant® Crack Set 10	1.14687
empty cells 16 mm with screw caps (25 pcs)	1.14724
MQuant® Universal indicator strips pH 7.5–14	1.09532
Sodium hydroxide solution 1 mol/L Titripur®	1.09137
Sulfuric acid 0.5 mol/L Titripur®	1.09072

For more information visit us at

SigmaAldrich.com/photometry



To place an order or receive technical assistance:
SigmaAldrich.com/support



For local contact information:
SigmaAldrich.com/offices

MilliporeSigma
400 Summit Drive
Burlington, MA 01803
SigmaAldrich.com

We have built a unique collection of life science brands with unrivalled experience in supporting your scientific advancements.

Millipore® Sigma-Aldrich® Supelco® Milli-Q® SAFC® BioReliance®

© 2026 Merck KGaA, Darmstadt, Germany and/or its affiliates. All Rights Reserved. MilliporeSigma, the vibrant M, BioReliance, Millipore, Milli-Q, SAFC, Sigma-Aldrich, Supelco, Spectroquant, MQuant, EMSURE, Certipur, and Titripur are trademarks of Merck KGaA, Darmstadt, Germany or its affiliates. All other trademarks are the property of their respective owners. Detailed information on trademarks is available via publicly accessible resources.

MS_AN14531EN Ver. 1.0 71301 09/2026

