

Fundamental soil analysis

Kiyoshi Tsutski, Prof. of Soil Science,
Obihiro University of Agriculture and Veterinary Medicine

Samples

Soil samples were collected from a soil profile in the experiment field of the Obihiro University of Agriculture and Veterinary Medicine.

Soil profile monoliths

No.	Layer	Depth	pH(H ₂ O)	EC μ S/cm	NO ₃ ppm	P ₂ O ₅ kg/10 a
Dry site						
1	Ap ₁	0-10 cm				
2	Ap ₂	10-25 cm				
3	2BC	25-30 cm				
4	3C ₁	30-45 cm				
5	3C ₂	45-73 cm				
6	3C ₃	73-98 cm				
Wet site						
7	Ap ₁	0-10 cm				

Soil analysis procedures

1. pH(H₂O)

Weigh 6 g of soil sample into a plastic centrifuge tube.

Add 30 mL of deionized water using a dispenser.

Soil to water ratio is 1:5.

Cap the tube and shake 30 minutes.

Measure the pH value using a pH meter.

2. Electric conductivity

Use the same soil – water suspension used for pH measurement.

Soil to water ratio is 1:5.

Measure the EC value using a EC meter and EC electrode.

Unit for the EC is mS/cm or dS/m (SI unit).

$$1 \mu\text{S/cm} = 0.001 \text{ mS/cm} = 0.001 \text{ dS/m}$$

3. Nitrate, NO₃ ppm

Use the same soil – water suspension used for pH measurement.

Filter the suspension through an filter paper No. 6 from Advantec Co. Ltd.

Nitrate concentration is measured using an NO₃ ion meter, Aqua-Duo for NO₃. Put a little volume of the filtrated solution on the sensor and read the concentration.

4. Nitrate, NO₃ ppm in crops

Squeeze the leaf of vegetable. The squeezed solution is transferred on the sensor of the NO₃ ion meter.

5. NO₃ ppm by test paper method. Try the test paper method and compare the results with those obtained by the ion meter method.

Procedures for the test paper methods are given in the following pages.

6. Available phosphate

Weigh 1.00 g of soil into a 50 mL plastic centrifuge tube.

Add 20 mL of Bray No.2 extractant and cap the tube tightly.

Shake vigorously for 1 minute.

Test paper stick PK of “Midori-kun” kit is used.

Dip the test paper stick for 10 seconds and wait 1 min for reaction.

See the test paper from the backside and compare the developed color with the color chart on the test paper container.

Reading on the color chart should be multiplied by 2, because soil : extractant ratio = 1:20 instead of 1:10.

Rapid Soil Diagnosis Kit “Midori-kun”

Translated by Dr. K. Tsutsuki from the manual of “Midori-kun”

This kit was developed for rapid diagnosis of soil using the soil test paper of ETS Company, USA as a base by the soil science laboratory of Tokyo University of Agriculture. Soil pH(H₂O) and soil nitrate nitrogen can be checked by “Midori-kun N” test paper, and water soluble phosphate and potassium by “Midori-kun PK” test paper. It is a product of Fujihira Co. Ltd, Tokyo, Japan.

By this kit, following items can be determined:

1. Soil pH and soil nitrate-N concentration,
2. Water soluble phosphate and potassium in soil,
3. Nitrate concentration in leaf stem of tomato, cucumber as a plant nutrition diagnosis kit,
4. Nitrate concentration in spinach and *Brassica campestris* as a food analysis kit,
5. N, P, K concentration in the nutrient substrate solution as a nutrient solution analysis kit,
6. Nitrate concentration in the ground water as an aquatic quality analysis kit.

How to use “Midori-kun” kit for soil diagnosis

1. Dig a trench or a soil-pit with around 15 cm depth, then insert a soil collection syringe in the central portion of the wall.
2. 5 cc (mL) of soil is collected from 5–10 cm depth.
3. Collected soil (5 cc) is pushed into a plastic bottle (100 mL).
4. Pure water (distilled water or de-ionized water) is added to the 50 mL level of the bottle. The bottle is capped tightly and shaken for 1 minute vigorously.
5. Dip the test paper “Midori-kun N” into the soil emulsion for 3 seconds, take out and wait 1 minute for completing the reaction. In case of

- “Midori-kun PK” paper, dip it 10 seconds, and wait 1 min for reaction.
6. See the test paper from the backside and compare the developed color with the color chart on the test paper container.

How to use “Midori-kun” for nitrate measurement in plant

1. Cut the leaf stem to small pieces by scissors.
2. Squeeze the leaf stem pieces and collect the squeezed liquid into any appropriate bottle.
3. Take 0.5 mL of the squeezed solution with a small (1 mL) plastic syringe.
4. Transfer 0.5 mL of the squeezed solution into a plastic bottle.
5. Add pure water to the 50 mL level of the bottle and mix well.
6. Dip the “Midori-kun N” test paper tip for nitrate concentration into the diluted solution for 3 seconds. “Midori-kun PK” test paper should be dipped for 10 seconds.
7. After reacting for 1 minute, compare the color of test paper with the color chart.
8. Multiply 100 to the obtained value to get the original concentration in the leaf stem.

How to read the color chart of “Midori-kun N”

1. pH(H₂O) value is applicable only to soil pH. The pH value of water or nutrient solution cannot be determined.
2. Nitrate-N remaining in soil (kg N/10a) can be read directly from the color chart.
3. Nitrate concentration in solution can be read in two modes: NO₃-N mg/L and NO₃ mg/L.

Soil diagnosis using the checked value

1. pH(H₂O)

Optimum pH for plant growth is usually between 6.0 and 6.5. If soil pH is lower than 6, soil-acidity should be corrected by liming. As a liming agent, dolomite (calcium magnesium carbonate) is recommended. Lime requirement cannot be obtained by this rapid method. Please follow the calibration curve method to obtain the lime requirement value. For the purpose of gardening, 100–200 g of dolomite should be applied to 1 m² of soil and mixed well.

2. Nitrate nitrogen

Though nitrogen is the most important nutrient for plant, it also causes damage at too high concentration and brings about high soil EC value. Appropriate nitrate-N concentration may differ by plants, but it is around 5 kg/10a. Necessity of additional application of nitrogen fertilizer is can be judged by referring to this value. In the case of greenhouse culture soil nitrate-N often reaches 10–15 kg/10a. In such case, additional nitrogen fertilizer application should be refrained from.

3. Water soluble phosphate

Water-soluble phosphate is the form readily available to plants. However, low phosphate level (lower than 5 kg/10a) can not be determined by this kit. This kit is recommended for the crop field or greenhouse field where high phosphate concentration is expected. The phosphate concentration higher than 10kg/10a means the excess in phosphate. In such case, decrease in phosphate fertilizer application or no application of phosphate should be considered. Excess in phosphate will cause root knot disease in Brassica vegetable or scam disease in potato.

4. Water soluble K

Water-soluble K is the form readily available to plants. However, K level lower than 5 kg/10a can not be determined by this kit. This kit is recommended for the crop field or greenhouse field where high K concentration is expected. The K concentration higher than 10kg/10a means the excess in K. In such case, decrease in K fertilizer application is recommended.

Cautions in using “Midori-kun”

1. “Midori-kun” is the rapid soil diagnosis kit. It should be used as a supplemental method for the original and conventional soil diagnosis analysis.
2. Nutrient concentration displayed on the upper column of color chart can be used when soil-water ratio is 1:10 as written in the manual. When the ratio is different from this ratio nutrient concentration in the lower column should be read and multiplied by the adopted soil-water ratio.
3. When the pH of soil-water emulsion is determined both by a glass-electrode pH meter and pH-test paper, two values will not coincide. In “Midori-kun”, the color of the color chart is calibrated so that it will coincide with the reading by the pH meter. Therefore, pH of the solution can not be determined correctly by “Midori-kun”.
4. The only necessary maintenance for “Midori-kun” is the proper preservation of test paper tips. After taking out tips from the container, it should be capped tightly again immediately to keep the remaining tips.