Method of Soil Diagnosis

IMPORTANCE OF SOIL DIAGNOSIS IN AGRICULTURE

Purpose 1

- Find out the soil-related factor inhibiting the growth of crops, and improve it.

Example →

Correct soil acidity

Correct phosphate deficiency

Improve drainage

Purpose 2

- Supply proper amount of nutrients necessary for the growth of crops, matching the nutrition status in soil.

Example →

Fertilizer application diagnosis

Purpose 3

Contribution to clean agriculture

← Excess fertilization pollute the environment

Nutrient absorption by plants

Nutrient holding capacity of soil

Present nutrient content in soil should be known.

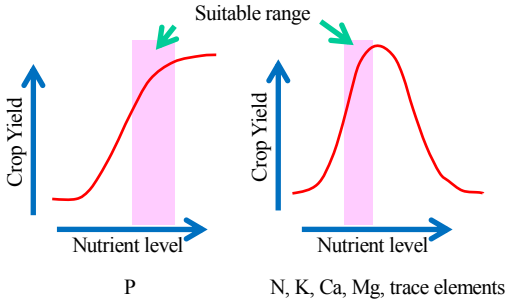
Disorder in crop growth caused by nutrition status of soil

- Scab disease of potato
  (too high soil pH)
- Infertility of rice・Softning
  (excess nitrogen, silicate deficiency)
- Bolting phenomena of vegetables
  (excess phosphate)

Disorder in crop growth caused by nutrition status of soil (2)

- Calcium deficiency of vegetables
  (Imbalance in basic cations)
- Decrease in quality of vegetables
  Lowering in sugar and vitamins
  (accumulation of nitrate)

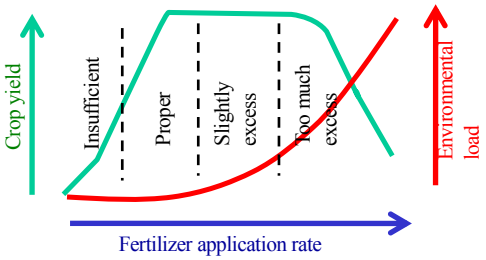
Crop yield and nutrient level



P

N, K, Ca, Mg, trace elements

Crop yield and environmental load



How Soil Diagnosis is carried out in Japan

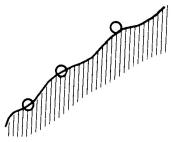
Method of soil sampling

Case 1: flat and homogeneous field

Collect from 5 places in a field

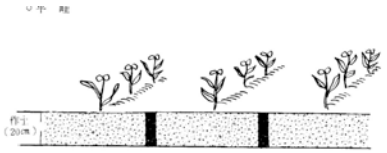
Method of soil sampling

Case 2: Slopes



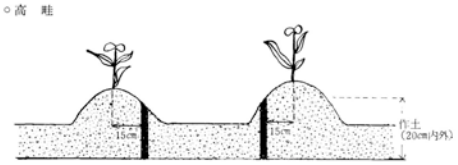
Separate into upper, middle, and lower portion. Collect 3 – 4 samples from each portion.

Method of soil sampling
Case 3: Flat furrow



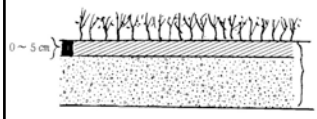
Central portion
between the row

Method of soil sampling
Case 4: High furrow



15 cm apart from the
center of the row

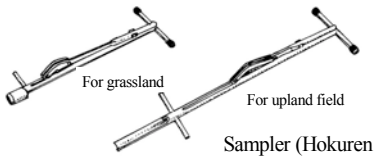
Method of soil sampling
Case 5: pasture grass field



5 cm deep sample
from the root mat.
Refrain from mixing
the withered grass.

Method of soil sampling
Necessary Tools

1. Sampler (Hokuren type)
2. Analysis order sheet
3. Plastic bags
4. Plastic bucket
5. Rubber band
6. Felt pen
7. Memopad with a ballpoint pen
8. others

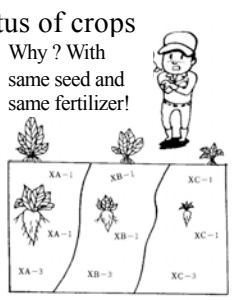


Sampler (Hokuren type)

Attention 1
in soil sample collection

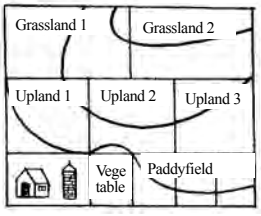
Growth status of crops

Why ? With
same seed and
same fertilizer!

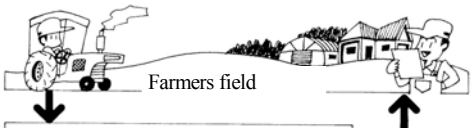


Attention 2
in soil sample collection

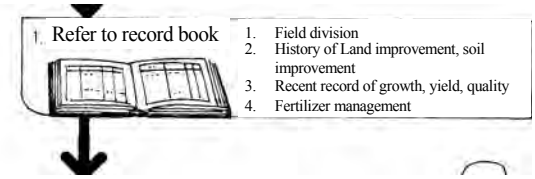
Field division



Flow sheet of soil diagnosis 1



Flow sheet of soil diagnosis 2



Mr.Hosono explains his farm managements

Scene of Soil Diagnosis Practice

(JICA Soil Diagnosis Course)

Field Laboratory

Flow sheet of soil diagnosis 3

Soil profile survey

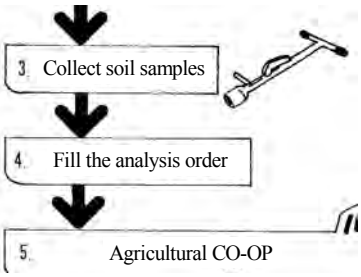
- Depth of plowed layer
- Texture of plowed and sub-layer soils
- Soil color
- Sand and stone
- Volcanic ash
- Wetness

What soil profile survey tells you:

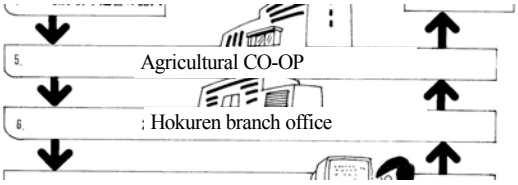
- What factor is limiting the plant growth (gravel, volcanic ash, clay, compaction of soil material, acidity, salt accumulation)
- Content and thickness of humus
- Drainage, water retention, dry or wet.
- Different soil layers composing the soil profile → History of soil

Andosoil profile in Obihiro Univ. Agr. & Vmed.

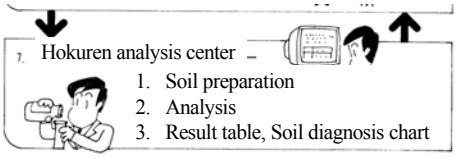
Flow sheet of soil diagnosis 4



Flow sheet of soil diagnosis 5

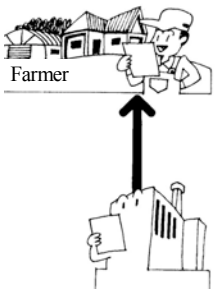


Flow sheet of soil diagnosis 6



Tokachi Federation of Agricultural Cooperative
Soil Analysis Laboratory

Flow sheet of soil diagnosis 7



Guidance and advice to farmers according to soil diagnosis result

Drying soil samples

Sieve soil samples (2mm)

Soil samples after preparation

Various Analysis Items and their significance

pH(H_2O)

- Concentration of free form H^+ in soil solution
- pH = − log (H^+)
- Add 25 ml of water to 10g of soil.
- Shake 30 minutes.
- Measure the pH of turbid suspension using pH meter.

Factors affecting soil pH(H_2O)

- Fertilizer application
- Nutrient absorption by crops
- Seasonal change in climate, precipitation
- Partial pressure of CO2
- Activity of soil microbes
- Decomposition of soil organic matter
- Saturation degree of soil bases
- Leaching of soil bases
- Nitrification (NH_4^+ , NO_3^-)

pH meter & EC meter

pH(KCl)

- Reflect the concentration of H^+ and Al^{3+} adsorbed electrostatically to clay and humus.
- pH(KCl) decreases when degree of saturation by basic cations is low.
- Add 25 ml of 1 M KCl to 10g of soil.
- Shake 30 minutes.
- Measure the pH of turbid suspension using pH meter.

Meaning of soil pH(KCl)

- Highly correlated with Al saturation degree of soil.
- pH(KCl) lower than 5.2 means
  → occurrence of exchangeable Al^{3+}
  → Inhibition of plant growth by Al^{3+}
- $Al^{3+} + H_2O \rightarrow Al(OH)^{2+} + H^+$
- $Al(OH)^{2+} + H_2O \rightarrow Al(OH)_2^{+} + H^+$

pH(0.01M $CaCl_2$)

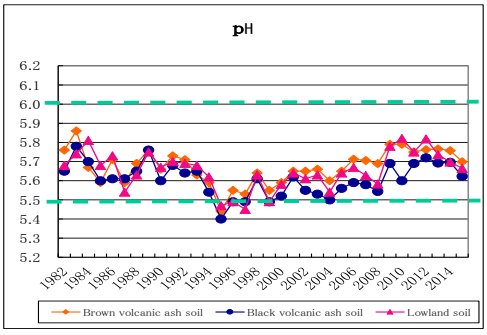
- Masking the effect of seasonal change and farm management
- To reflect the actual root zone environment more accurately, soil pH under dilute electrolyte concentration is more appropriate.

Meaning of soil pH

< 5.0	Very acidic
5.0 – 5.5	Acidic
5.5 – 6.0	Weakly acidic
6.0 – 6.5	Slightly acidic
6.5 – 7.0	Neutral
7.0 – 7.5	Slightly alkaline
7.5 – 8.0	Weakly alkaline
8.0 – 8.5	Alkaline
8.5 <	Very alkaline

Change in soil pH in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



Effect of pH on plant growth

- H^+ ion inhibits the function of root (pH < 4)
- Increase in Al^{3+} ion (Inhibit growth at >1 ppm level)
- Inhibit absorption of N, P, K, Ca, Mg, B, Mo and symptom of deficiency (in acidic range)
- Excess in Cu, Zn, Mn, Fe (in acidic range)
- Deficiency in Cu, Zn, Mn, Fe (in alkaline range)

Exchangeable Acidity

- Weigh 10 g of air dried soil in to a flask or bottle.
- Add 25 mL of 1N KCl.
- Shake for 1 hour.
- Filter through a filter paper (Advantec No.6).
- Take 10 mL of the filtrate into a flask and titrate with 0.1 N NaOH.
- Consumed mL is multiplied by 12.5.
- Obtained value is Y_1.

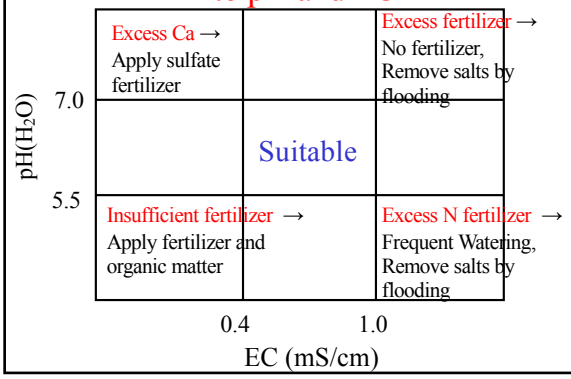
Electric conductivity（EC）

- Reflect total concentration of water soluble ions in soil solution
- Add 50 ml of deionized water to 10g of soil, shake 30 min. Measure EC of turbid suspension using EC meter.
- Unit is S/m, mS/cm or μS/cm, S: Siemens
  (1S/m=10 mS/cm = 10^4 μS/cm)

Meaning of soil EC

- High correlation with nitrate NO_3^- content
- Malnutrition under low EC(< 0.1 mS cm^{-1})
- Growth damage at high EC (> 1 mS cm^{-1})
- Adjust fertilizer application rate according to EC

Greenhouse soil diagnosis according to pH and EC



Application rate of basal fertilizer (N, K) according to soil EC（dS m^{-1}） in upland field

Soil Type	< 0.3	0.4-0.7	0.8-1.2	1.3-1.5	1.6 <
Humic andosoil	Standard rate	2/3	1/2	1/3	No fertilizer
Sandy・Fine textured	Standard rate	2/3	1/3	No fertilizer	No fertilizer
Sand dune/ immature	Standard rate	1/2	1/4	No fertilizer	No fertilizer

Humus

- Humus = Soil organic matter

Method of determination

- Rapid estimation by soil color
- Tyurin method（Potassium dichromate oxidation/ Titration）
- Dry combustion method（Instrumental analysis）

Standard Soil Color Chart Hue 7.5YR

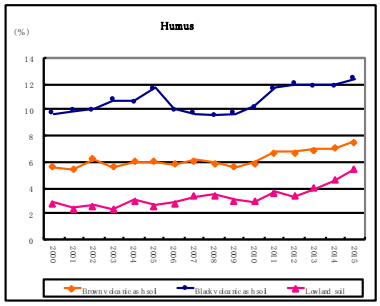
Relationship between soil color and organic matter content

Importance of humus

- Soils with high humus content are generally fertile and easily manageable.
- Exception → Andosoil (Kuroboku in Japan)
- Supply nutrients (especially N)
- Hold soil moisture
- Hold nutrients（Cation Exchange Capacity）
- Formation of Soil Aggregate Structure

Change in soil humus in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



Nitrogen Analysis

- Nitrogen is the most important constituent of fertilizer.

Inorganic nitrogen

- Ammonium nitrogen
  Extracted by 1N KCl, 2N KCl
- Nitrate nitrogen
  Extracted by Water, 1N KCl, 2N KCl
- Determine by steam distillation/ titration or colorimetry
- Rapidly available to crops

Available nitrogen

- Potential amount of inorganic nitrogen formation
- After incubating 4 weeks at 30 ℃, total amount of formed inorganic nitrogen is determined.
- Incubation under upland or paddy condition.
- Problem: Time consuming method