Phosphate buffer (pH7) extraction method (Rapid estimation method for available nitrogen)

- Extracted nitrogen content or absorbance at 420 nm of the extracted solution showed high correlation with available nitrogen estimated by incubation method.

Hot water extractable nitrogen

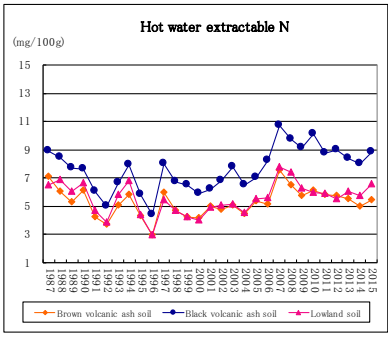
- Another measure of available nitrogen
- Soil + water (1:10)
- Autoclaved (105 ℃/modified to 121 ℃, 1 hour)
- Filtered
- Extracted solution is digested by Kjeldahl method
- Nitrogen is determined by colorimetry

Adjustment of N application rate according to hot water extractable nitrogen

Hot water N (mg / 100 g)	N application rate (kg / 10 a)
1, 2	24
3, 4	20
5, 6	16
7, 8	12
9, 10	8
Higher than 11	8

Change in hot water extractable N in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



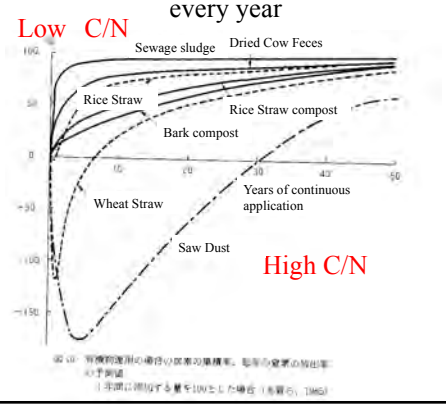
Total Nitrogen

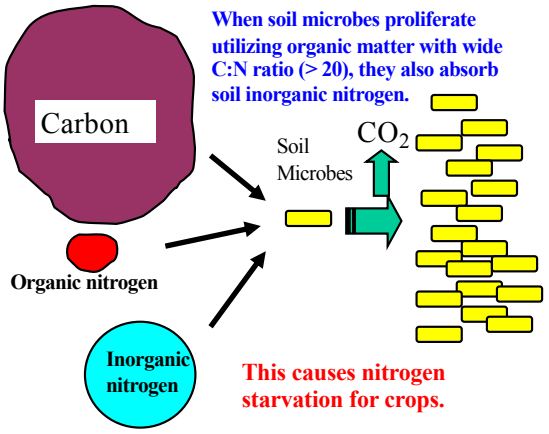
- Kjeldahl digestion (conc H_2SO_4 + K_2SO_4 + Catalyst(Cu, Hg, Se))

  Organic N → NH_4^+
- Instrumental (Dry combustion method)
- C/N is calculated
- C/N is related to the pattern and rate of nitrogen mineralization

Kjeldahl digestion apparatus

Release of N from organic matter applied to soil every year





Expected N release (kg) from 1t of organic matter (dry matter) during the following 1 year

Type of Organic Matter	Released N (kg)
Sewage sludge	70 (maximum)
Dried cow feces	31
Mature compost	19.9
Intermediately mature compost	19.5
Bark compost	19.5
Rice straw	6.5
Rice husk	5.4
Wheat straw (after long term application)	3.3
Saw dust (after long term application)	2.1

Adjustment of Fertilizer Application Rate according to Organic Matter Amendment (/ 1 t)

Organic Matter	N (kg)	P_2O_5 (kg)	K_2O (kg)
Crop residue compost	1	1	4
Bark compost	0	2	2
Cow feces + straw compost	2	4	7
Cow feces + bark	2	3	5
Chicken manure + bark	3	12	9
Municipal refuse compost	3	3	4
Food company garbage compost	10	7	3
Sewage sludge compost	13	15	1

Available Phosphate

- Limited resources of phosphate.
- Deficiency is common in most of soils.

Available phosphate

- Soil phosphate which is readily absorbed by plants.
- Various extraction methods has been proposed and correlation between crop growth has been examined.
- Suitable method differs depending on soil types and crops.

Various methods for Available phosphate

- Truog method (for neutral - acidic soils)
- Bray Method (No.1, No.2, No.2 modified)
  (for neutral – highly acidic soils)
- Olsen method
  (for high pH – $CaCO_3$ affected soils)
- 2.5% acetic acid extraction method
  (for Ca type phosphate)
- Mehlich 3 method
  (for soil with pH 5.2 – 8.2)

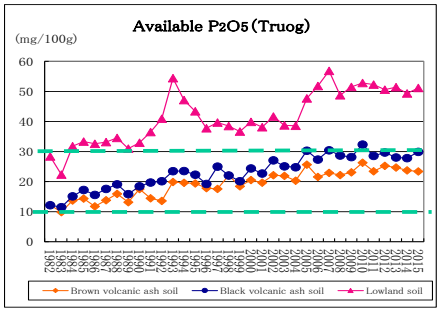
Flow Injection Analysis of CEC and available phosphate

Truog method

- 0.001 M H_2SO_4 (with 0.3% ammonim sulphate)
- Soil : Extractant 1 : 200
- Shake 30 min
- Colorimetry (Molybdenum blue method)
- Calcium form phosphate
- Applied to upland field, vegetable field, orchard field, paddy nursery soil in Japan

Change in available P_2O_5 (Truog) in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



Bray No2 modified method

- 0.03M NH_4F + 0.1M HCl
- Soil : Extractant 1:20 (grassland soil)
  1:10 (paddy soil)
- Shaking time 1 minute
- Ca form phosphate, and partially Al form + Fe form phosphate are extracted.
- Applied to Paddy soil and Grassland soil in Japan

Olsen method

- To 5g of soil, 0.5 M $NaHCO_3$ 100ml and 1 g of Active Charcoal were added.
- Shake 30 minutes
- Applied to soils with alkaline pH

Mehlich 3 method

- 1 g of soil is extracted with 10 mL of extractant solution (0.2M CH_3COOH, 0.25M NH_4NO_3, 0.015M NH_4F, 0.013M HNO_3, and 0.001M EDTA) by shaking during 5 min. Extacts are filtered through Whatman 42 paper. P determined by colorimetry (Molybdenum blue method).
- Mehlich 3 test often measures more P than Bray 1-P on high pH, $CaCO_3$ affected soils.

2.5% acetic acid extraction

- 1 g of soil is extracted with 100 mL of 2.5% acetic acid once, then with 50 mL of ammonium chloride two times.
- Calcium form phosphate is extracted
- Applied to wheat field soil
- Developed in Japan, but not yet so popular.

Available Phosphate（Truog）and application rate of P-fertilizer to upland crops

Available P_2O_5 mg/100g	Diagnosis	application rate of P-fertilizer
0 - 5	Insufficient	150 %
5 - 10	Slightly insufficient	130 %
10 - 30	Suitable	Standard rate
30 - 60	Slightly high～High	80%
> 60	Excess	50%

Available Phosphate（Truog）and application rate of P-fertilizer to vegetable field

Available P_2O_5 mg/100g	Diagnosis	application rate of P-fertilizer
<10	Insufficient	120 %
10 - 20	Slightly insufficient	Standard rate
20 - 50	Suitable	Standard rate
50 - 100	Slightly high～High	50 – 80%
> 100	Excess	No application

Exchangeable bases and cation exchange capacity

Extraction apparatus for CEC

Exchangeable bases (Ca, Mg, K)

- Exchangeable bases are extracted with 1M ammonium acetate and determined.
- Atomic absorption spectrophotometer and flame photometer are used for determination.
- Exchangeable cations are readily available to crops.

Change in exchangeable CaO in Tokachi

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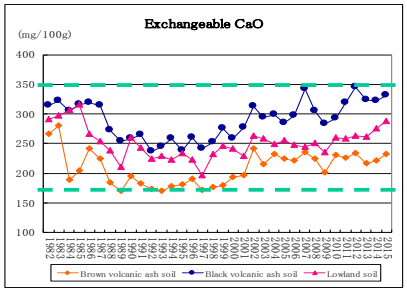
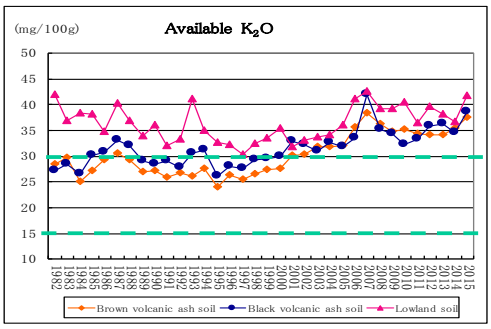


Change in exchangeable K_2O in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



Contents of exchangeable K_2O and adjustment of K fertilizer to upland crops

Exch. K_2O mg/100g	Diagnosis	K fertilizer application Values in ( ) are for potato
0 - 8	Insufficient	150 % (130 %)
8 - 15	Slightly insufficient	130 % (110 %)
15 - 30	Suitable	Standard rate
30 - 50	Slightly high	60% (50 %)
50 - 70	High	30% (20 %)
> 70	Excess	0% (0 %)

Cation Exchange Capacity (CEC)

- Capacity of Soil to hold cations electrostatically
- Due to minus charge on clay-minerals and humus
- Soil is first saturated with NH_4^+ by pH7 1M ammonium acetate, then eluted with 1 M KCl.
- Eluted NH_4^+ is determined.

Standard Value for CEC

- Fundamental data for soil improvement and fertilizer management.
- Sand-dune immature soil 3-10 $cmol_c/kg$
- Gray lowland soil・Light colored andosoil 15-25 $cmol_c/kg$
- Humic andosoil 20-30 $cmol_c/kg$

To increase CEC

- Soil dressing using clayey soil
- Organic matter amendment for many years
- Increasing CEC will be a hard work for farmers

Macro elements

- C, H, N, O
- P, K, Ca, Mg, S

are applied by fertilizers.

Trace Elements

- Fe, Cl, B, Mn, Cu, Zn, and Mo are essential trace elements for plants
- Cu and Zn are extracted with 0.1N HCl (1:5)
- Boron is extracted with hot water.

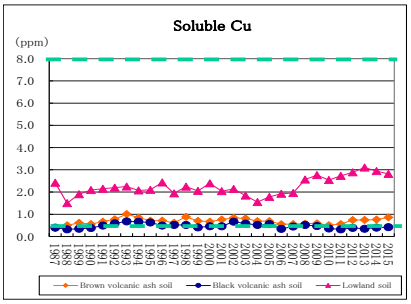
Atomic Absorption Spectrometer

Soil diagnosis standard for trace elements

Items	Standard Value	Remarks
Soluble Cu (Cu) in 0.1N HCl	0.5～8.0 ppm	Wheat（def.） Azuki（excess）
Soluble Zn (Zn) in 0.1N HCl	2～40ppm	Corn・wheat (deficiency)
Hot water soluble B (B)	0.5～1.0ppm	Beet （deficiency）

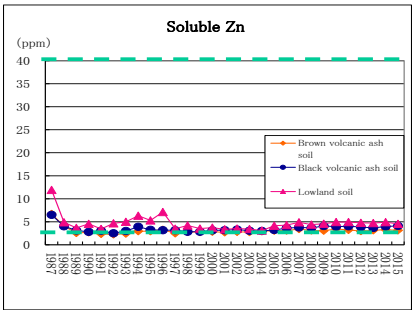
Change in soluble Cu in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



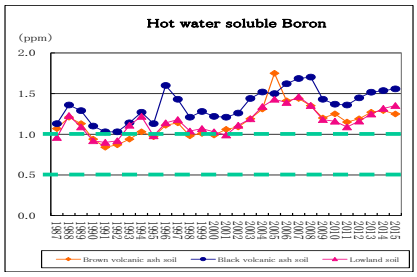
Change in soluble Zn in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



Change in hot water soluble B in Tokachi

Tokach Federation of Agricultural Co-operatives, Institute



Soil types and disorder in trace elements

Deficiency	Type of soils
Cu	High pH soil, humic andosoil
Zn	Sandy soil, High pH soil, peaty paddy soil
B	Sandy soil, High pH soil, peaty soil

Phosphate absorption coefficient

- Indicator for phophate absorption by soil
- Add 50ml of ammonium phosphate (pH 7.0, 13.44g P_2O_5 /l) to 25 g of dried soil. Shake 24 hours, filtered, and phosphate concentration in the filtrate is determined.
- Absorbed amount of phosphate is calculated from the difference between blank and sample.
- Expressed by absorbed amount (mg) of P_2O_5 by 100 g of soil.

Significance of phosphate absorption coefficient

- Indicator for identifying Kuroboku soil. (＞1500 mg P_2O_5/100g)
- Estimate the rate of phosphate application.
- Instead of chemical determination, near-infrared analysis is also used.

Near-infrared analyser

Other useful elements

- Na for sugar beet
- Si for rice
- Al for tea

Are useful for limited types of plants.

Other items for soil diagnosis

- Particle size analysis
- Penetrometer
- Enzyme activity (α-Glucosidase)
- Nematodes

Data processing

Soil diagnosis chart of Tokachi federation of Agricultural Cooperatives

Application of soil diagnosis is beneficial for

- Proper fertilization
  - Save fertilizer cost
  - Secure healthy growth and high yield
  - Prevent environmental pollution by excess fertilizer.
  - Maintain soil fertility
  - Prevent soil deterioration

Use of Soil Diagnosis in Tokachi District

- 24.1 % of farmers are practicing soil diagnosis annually.
- 47.1 % occasionally.
- 23.1 % have some experience.
- 5.7 % have no experience of soil diagnosis.
- Results of soil diagnosis are used to calculate the application rates of fertilizers and soil improving materials.