A. Olsen Method (Neutral to Alkaline Soils)

Principle

Sodium bicarbonate extractant releases calcium-associated phosphorus.

Reagents

- 0.5 M $NaHCO_3$ extractant (pH 8.5), Ammonium molybdate reagent, Stannous chloride or ascorbic acid reducing agent.

Instrument

- Spectrophotometer (~730-840 nm).

Procedure

1. Shake 2.5 g soil with 50 mL $NaHCO_3$ extractant for 30 minutes.
2. Filter extract.
3. Develop blue color with molybdate reagent.
4. Measure absorbance against standard curve.

B. Bray I Method (Acidic Soils)

Principle

Acidic ammonium fluoride extractant dissolves Fe/Al-bound phosphorus.

Reagents

- Bray I extractant (0.03 N NH_4F + 0.025 N HCl), Ammonium molybdate reagent, Reducing agent.

Instrument

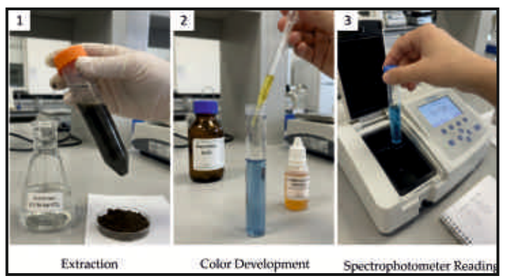
- Spectrophotometer (~660 nm).

Procedure

1. Shake 2 g soil with 20 mL Bray extractant for 1 minute.
2. Filter immediately.
3. Develop blue color.
4. Measure absorbance.

Important Notes

- Always determine soil pH before selecting method.
- Olsen method preferred for neutral to alkaline soils.



Available Potassium (K)

Available potassium represents the exchangeable and water-soluble fraction accessible to plants. Potassium regulates osmotic balance, stomatal function, enzyme activation, drought tolerance, and resistance to biotic and abiotic stress. Soil K status is influenced by clay minerals, cation exchange capacity (CEC), and soil moisture dynamics.

Method

Neutral Normal Ammonium Acetate Extraction (NH_4OAc Method)

Principle

Ammonium ions (NH_4^+) displace exchangeable potassium (K^+) from soil exchange sites. Extracted potassium is quantified using flame photometry.

Reagents

- 1N ammonium acetate (NH_4OAc), adjusted to pH 7.0.
- Standard potassium solutions for calibration.

Instrument

- Flame photometer.

Procedure

1. Weigh 5 g air-dried soil into extraction bottle.
2. Add 25 mL 1N NH_4OAc extractant.
3. Shake mechanically for 30 minutes.
4. Filter using Whatman filter paper.
5. Calibrate flame photometer using K standards.
6. Aspirate extract and record readings.
7. Calculate available K and express as kg ha^{-1}.

Calibration and Measurement Notes

- Prepare fresh calibration standards covering expected K range.
- Check instrument stability with intermediate standard after every 10–15 samples.
- Maintain consistent aspiration rate.

Common Errors to Avoid

- Improper extractant pH (must be ~7).
- Dirty burner head causing unstable flame.
- High Na interference if instrument not properly adjusted.

General Laboratory Quality Control

- Calibrate all instruments daily.
- Use analytical grade reagents.
- Maintain fixed soil: solution ratios.
- Include blanks and check standards.
- Record batch number and analysis date.

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STANDARD SOIL ANALYSIS PROTOCOLS

Field Sampling and Laboratory Determination of pH, EC, SOC, Available N, P and K

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(AN AUTONOMOUS BODY OF MOEF & CC, GOVT. OF INDIA)

Soil Sampling Protocol

Representative soil sampling is the most critical step in soil analysis. Errors during sampling cannot be corrected during laboratory analysis. Proper sampling ensures meaningful interpretation and nutrient recommendation.

Equipment

- Soil auger
- Spade
- Sample bags
- Marker/labels
- GPS

Sampling Strategy

- Divide field/site into homogeneous units (soil type, slope, vegetation).
- Avoid abnormal spots (bunds, Near tree canopy, waterlogged zones).
- Follow zigzag pattern across sampling area.
- Remove surface litter before collecting soil.

Depth

- Agricultural soils: 0-15 cm/0–30 cm.
- Plantations: 0-45/0-60 cm
- Subsoil studies: additional depths (30–60 cm, 60–90 cm).

Sample Preparation

1. Collect 8–10 cores per unit.
2. Mix thoroughly in clean sheet/bucket.
3. Quarter to obtain ~500 g composite sample.
4. Air-dry under shade.
5. Crush gently and sieve through 2 mm.

Storage

- Label: location, depth, date, crop/vegetation.
- Store dry samples in sealed bags.

Suggested Photos

- Zigzag sampling diagram.
- Composite sample mixing.

Soil Ph And Electrical Conductivity (EC)

- Soil pH controls nutrient solubility, microbial activity, metal toxicity, and fertilizer efficiency. It strongly influences availability of N, P, K and micronutrients.
- Electrical Conductivity (EC) indicates soluble salt concentration and reflects salinity status, osmotic stress, and potential restrictions on plant growth.

Method

Soil-water suspension (1:2.5 ratio)

Reagents

- Distilled or deionized water.
- Standard buffer solutions (pH 4.0, 7.0, 9.2) for calibration.

Instruments

- Digital pH meter with glass electrode.
- Conductivity meter (EC meter).

Procedure

1. Weigh 20 g air-dried, 2 mm sieved soil into a clean beaker.
2. Add 50 mL distilled water.
3. Stir or shake intermittently for 30 minutes.
4. Allow suspension to equilibrate.
5. Calibrate pH meter using standard buffers before measurement.
6. Insert electrode carefully and record pH.
7. Measure EC in the same suspension and report as dS m^{-1} at 25°C.

Interpretation of Soil pH

pH Range	Classification	Implications for Soil Fertility
< 5.5	Strongly acidic	Al/Mn toxicity risk; low P availability
5.5 – 6.5	Moderately acidic	Suitable for many crops; micronutrient availability high
6.5 – 7.5	Neutral (ideal range)	Maximum nutrient availability; optimum biological activity
7.5 – 8.5	Slightly alkaline	Possible micronutrient deficiencies (Zn, Fe)
> 8.5	Strongly alkaline/sodic	Poor structure, reduced nutrient availability

Ideal pH for most crops and tree seedlings: 6.5 – 7.5

Interpretation of Electrical Conductivity (EC)

EC (dS m-¹)	Salinity Class	Plant Response
< 1.0	Non-saline	No restriction for most crops
1.0 – 2.0	Slightly saline	Sensitive crops may show stress
2.0 – 4.0	Moderately saline	Yield reduction in sensitive species
> 4.0	Highly saline	Significant growth inhibition

Soil Organic Carbon (soc) And Available Nitrogen (N)

Soil Organic Carbon (SOC)

Soil organic carbon is a primary indicator of soil health. It influences nutrient availability, aggregation, water retention, microbial activity, and long-term soil productivity. SOC is closely linked with nitrogen mineralization potential and soil biological activity.

Method: Walkley and Black Wet Oxidation Method.

Reagents

- 1 N potassium dichromate ($K_2Cr_2O_7$)Concentrated sulfuric acid (H_2SO_4)
- Ferrous ammonium sulfate (FAS)Diphenylamine indicator
- Orthophosphoric acid (optional).

Procedure

1. Weigh 1 g air-dried soil into digestion flask.
2. Add 10 mL 1N $K_2Cr_2O_7$.
3. Add 20 mL conc. H_2SO_4 carefully, swirl gently.
4. Allow oxidation reaction for 30 minutes.
5. Dilute with distilled water.
6. Add indicator and titrate excess dichromate with standardized FAS until endpoint (green color).
7. Calculate SOC (%) using standard formula.
8. Run reagent blank for correction.

Available Nitrogen (Alkaline $KMnO_4$ Method -Subbiah & Asija)

Available nitrogen represents easily mineralizable organic nitrogen and reflects soil N-supplying capacity. It is influenced by organic matter content and microbial activity; therefore, interpretation alongside SOC is recommended.

Reagents

- 0.32% $KMnO_4$ solution
- 2.5% NaOH solution
- Boric acid solution with mixed indicator
- Standard sulfuric acid.

Instrument

- Kjeldahl distillation unit.

Procedure

1. Weigh 5 g soil into distillation flask.
2. Add $KMnO_4$ and NaOH solutions.
3. Distill liberated ammonia.
4. Capture NH_3 in boric acid indicator solution.
5. Titrate with standard acid.
6. Express available N as kg ha^{-1}.

Available Phosphorus

Phosphorus availability is strongly influenced by soil pH. In acidic soils, P binds with Fe and Al; in alkaline/calcareous soils, it forms Ca-bound compounds. Therefore, extraction method must be selected based on soil reaction.

Method Selection

- Soil pH < 6.5: Bray & Kurtz Method (Bray I)
- Soil pH ≥ 6.5: Olsen Method.